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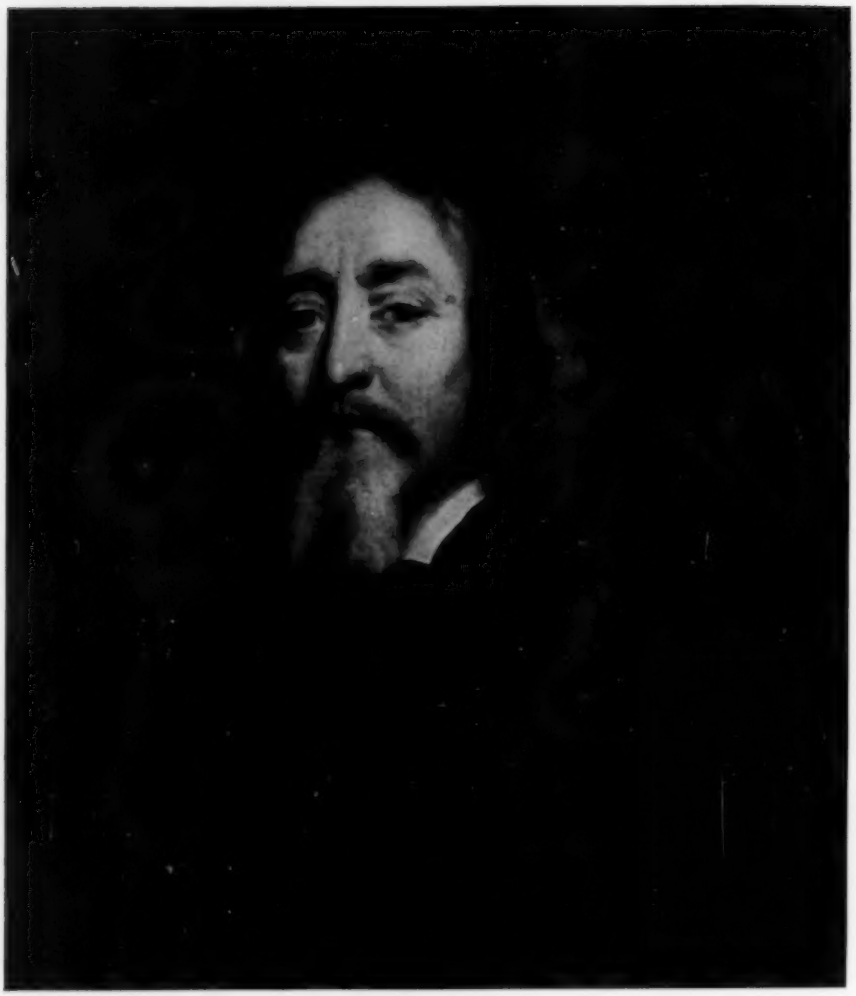


Portrait of COMENIUS
by JURRIAN OVENS.

UNIV. OF MICH.

Third Preface to Volume XXX

Comenius redivivus

The European unrest and chaos of to-day bring back to our minds the conditions which obtained three hundred years ago during the Thirty Years' War. That war, or rather those wars, were ended in 1648 by the Peace of Westphalia, which was to be the beginning of new evils. During that dismal period the greatest European figure was not that of any one of the kings and emperors, of the generals, bishops, and diplomats, but that of the Czech educator, JAN AMOS KOMENSKÝ, better known under his Latin international name, COMENIUS.

COMENIUS was the perfect embodiment of all the aspirations of his people, for he loved his native Bohemia above all nations, he was one of the leaders of the native church, the *Unitas fratrum bohemorum*, and the only languages he used in his writings were Latin for international purposes and Czech for the edification of his political and religious brethren. He may be taken also as an excellent symbol of the terrible vicissitudes of those days, for he spent the main part of his life in exile, and his home was thrice destroyed. He left Bohemia in 1628, and then spent a dozen years in Poland, nine months (1641-42) in England, eight years in Sweden and the Hanseatic town of Elbing, four years in Hungary, and finally fourteen in Holland (1). This enumeration does not include shorter journeys or sojourns, nor should we forget his student years at Herborn in Hesse-Nassau and Heidelberg. Political cruelty and religious fanaticism have caused (and are causing) many men to spend their life in exile, but few exiles if any, have been obliged to wander across so many countries

(1) COMENIUS was born in Moravia on March 28, 1592. He died in Amsterdam on November 15, 1670 and was buried not far from that city in the Walloon church of Naarden. A memorial tablet was inaugurated there in 1892 to celebrate the third centenary of his birth.

or to establish and abandon so many homes. As a result, a deep study of COMENIUS' life and works, based as it should be on archival documents, would involve a degree of polyglottism which few students can ever hope to obtain, for your " complete Comenian scholar " should be prepared to read manuscript documents not only in English, German and Latin (that is nothing) but also in Czech, Danish, Swedish, Dutch, Polish and Hungarian !

To illustrate the unhappiness of COMENIUS' life it will suffice to recall that he witnessed the destruction of his home three times, and that he could never travel very far in those days, he who travelled so much, without coming across the atrocities of war or the indignities of tyranny and persecution. Being orphaned at the age of twelve he was taken in by relatives in Strážnice (Moravia), which was soon devastated by *Hungarian* soldiers under STEPHEN BOCSKAI. A few years later the Thirty Years' War began and things became more and more devilish. In that very year 1618 COMENIUS had been called to the pastorate of Fulnek and was rector of the Brethren's school in that Moravian town. Three years later Fulnek was sacked by *Spanish* troops, and COMENIUS lost all of his books and manuscripts. After that he was more lucky or more wary, and escaped further destruction for more than thirty years. However, such luck could not last forever and having returned to the Polish town of Leszno, where he had spent previously some of the most fertile and happy years of his life, COMENIUS met with a new disaster. The very town which the Swedish soldiery had respected was sacked by *Poles* (it was a Polish town) in 1656 and completely destroyed. The libraries and archives of the Brethren, as well as COMENIUS' own manuscripts, were obliterated. We have an account of that tragedy in his own hand *Lesnae excidium anno MDCLVI in Aprili factum fide historica narratum* (a booklet of fourteen pages printed in the same year in Amsterdam). Alas ! there are thousands of scholars today in Europe and America who have been deprived of their books and papers in the same way and driven into exile and destitution, who, if their eyes chance to fall upon these lines, will understand them as no one else could. They may have experienced the destruction of a beloved home, not by a natural catastrophe (which would be far easier to bear) but because of the wickedness of other men. Let them remember that COMENIUS

experienced that torture three times and lived forty-two years in exile and penury.

I have outlined the very dark background of the picture and now let us look at the luminous center of it, COMENIUS' own personality, which in spite of all those miseries and cruelties, remained to the last radiant with hope, faith and charity. Nothing could make him swerve from his great undertakings though he was but too often obliged to stop and wait.

His purpose was threefold. I put it deliberately that way, for it is not as if he had been pursuing three separate purposes. It was rather a single purpose having three different aspects, national, linguistic and religious. The religious aspect was the first to draw my attention to him. A few years ago I attended a Nativity Play in Bethlehem College, a school for colored girls in Malvern, Jamaica (2). I was much impressed by the performance and took pains to know more about the school. I was told it was one of the Moravian schools which are numerous in the West Indies. Now the Moravian church is but a continuation of the great religious effort which began in Bohemia not long after HUS' martyrdom (1415). The *Unitas fratrum*, as the new brotherhood was called at the time of its formal establishment by PETR CHELČICKÝ in 1458-9, was an attempt to revive the principles and the simple practice of evangelical Christianity. COMENIUS was born in the bosom of that brotherhood, he became one of its leaders as well as one of its most faithful servants. In the face of an ugly world he tried to live the good life according to the Gospels and wherever he was or whatever his special duties of the moment might be, he never stopped very long his loving efforts on behalf of his brethren. The Unity was then essentially Bohemian; their books of devotion were written in Czech, the most precious of all being the so-called Kralice Bible, that is, the Czech translation of the Bible published by the Brethren at Kralice from 1579 to 1593. A good many of COMENIUS' writings were devoted to the Unity and these were all written in the Czech language. Thus the defense of his mother tongue, of his church, and of his people was but one struggle which lasted just as long as his life (3).

(2) *Isis* 21, 497, 1934.

(3) To prevent confusion I must say that the Moravian Church of to-day,

However, the very fact of being compelled to live in exile, often far away from his spiritual family, obliged him to take an international view of his responsibilities. Did not a man's duty to God and to his fellow men remain the same everywhere? His main task, as he conceived it, was to educate his Brethren, to teach them all the knowledge that was needed to make of them good citizens and good Christians. At the beginning he had been thinking mostly, if not exclusively, of his Brethren, in the narrower sense, the Brethren of the Unity, whose shepherd he was, but by and by he realized that the duty of education extended to the whole of mankind. The Brethren themselves had developed very early missionary tendencies, the satisfaction of which inspired and sustained their diaspora.

COMENIUS was a born pedagogue and his most lasting contribution, in the eyes of posterity if not in his own, was the writing of a whole series of elementary textbooks for the teaching of languages, and not only for that, for it was one of his leading ideas that it never suffices to teach words, one must explain the things which these words signify, explain nature, teach science and religion. It is not easy to measure COMENIUS' pedagogical achievements, for few if any of his ideas were absolutely new; the novelty consisted in their combination; moreover he presented them so effectively that they were gradually imitated and assimilated and have permeated anonymously the whole of modern education. Yet all of his teachings are not yet understood, that is, they are not understood well enough to be put into practice. For example, judging by the number of students who spend many years learning Latin and end by *not* knowing it, it is clear

though it is a continuation of the Unity, is very different from it. To begin with, it is no longer Moravian except in name; for example, the American province is largely German in spirit, not Czech. It should be recalled that after having been almost obliterated by persecutions, the Unity was reorganized in 1722 at Herrnhut in Saxony, being called "The renewed church of the united brethren." The evangelical and missionary tendencies of the early church are still blossoming, but the theological structure has been modified. The old theological foundation was Calvinistic and this explains why COMENIUS completed his studies in the academy of Herborn and the University of Heidelberg. In 1748, the renewed church accepted the Augsburg confession (i.e., the confession of faith formulated by MELANCHTHON in 1530, and canonized by the Lutheran church in 1555). That is, the new church is more Lutheran than Calvinistic, and far more German than Bohemian.

that Latin is not yet taught as it should be. True enough it was easier to teach it in a living manner three centuries ago when it was still the international language of the Republic of Letters, than it is now when its international usage is restricted to the clerks of the Roman Catholic Church. Nevertheless Latin would not have died, as it almost did, on the teachers' hands if the latter had been more alive. There are dead languages, which no one is left to speak, but Latin is decidedly not one of them. The expression as applied to Latin, Greek, Arabic, Sanskrit, etc. is decidedly false; there are no dead languages (in that sense) but only dead teachers. COMENIUS' quaint textbooks, the *Janua*, the *Vestibulum*, the *Atrium*, the *Janua rerum*, the *Orbis sensualis pictus* (the ancestor of illustrated schoolbooks), the *Schola ludus*,—not to speak of the unpublished *Violarium*, *Rosarium*, *Viridarium*, and *Labyrinthus*—were immensely successful. Some were reprinted everywhere, adapted to many languages, sometimes to the simultaneous study of three, four or five languages, and their editions, translations, adaptations, multiplied indefinitely. Well might COMENIUS be styled " paedagogus mundi "; he was exactly that, as witnessed not only by the innumerable editions of his books, but also by the astounding competition of many countries for his advice and services. He tested and revised every one of the accepted educational theories or provided theories where there was no guide but blind tradition, he conceived a new system of public schools such as is now taken for granted in every civilized nation, he explained the need of free education not only for boys but also for girls, in proportion to the intelligence of each one and not in excess of it; he insisted that nature itself should always be the main font of inspiration and information, that every one of the student's senses, especially his eyes and ears, should be enlisted, and his power or reflexion stimulated; that the process of learning should be as orderly, easy, and spontaneous, even joyful, as possible; he set forth the fundamental importance of religious education, of civic training, of manual work, of parental coöperation with the teachers; he emphasized the moral necessity as well as the insufficiency of knowledge. In short there is hardly one of the educational theories of today of which one cannot find the development or at least the germ in the didactic writings of the great Bohemian teacher.

COMENIUS is the COPERNICUS of education; that is his outstanding merit. He was many other things but it was only as a pedagogue that he excelled his contemporaries and impressed his thoughts on posterity. He was not an original scientist and his interest in science was still essentially of the scholastic type. For example, he could not accept the new astronomy, for it did not tally with the Scriptures. Nor was he a philosopher. His "pansophy," to which he attached far more value than to his educational views, was but a childish mixture of encyclopaedism, ethics, chiliasm and vague ideas of many kinds. He was not even a theologian, but simply, and that is very much indeed, a good and conscious Christian.

The circumstances of his life made of him a citizen of Europe. His love of Bohemia, intense as it was and exasperated by persistent misfortune, never degenerated into hatred of other nations and therefore he became one of the founders of internationalism. One of the very conditions of sound internationalism, it should be remembered, is sound nationalism. Even as we could hardly trust the man who betrayed his own family, we could not trust him who failed to love his own country, his own people. The larger loyalty implies the lesser one and can hardly exist without it.

In the same way his religion was never perverted into hatred of the religion of other people and in his growing concern and passion for peace, he realized more keenly than anybody else and ahead not only of his contemporaries but even of a great many of our own, that the example of peace and charity should be given by the churches of Christ. If the churches could not live in peace, how could one ever expect nations to do so?

Knowledge, peace and charity. COMENIUS' triple message is more needed to-day than ever, when peace and charity are forgotten in many countries, and knowledge is prostituted to evil aims.

COMENIUS was defeated in 1648 when Bohemia was excluded from the treaty of Westphalia and the Czechs sold out to the greater powers. He was defeated again at Munich in September 1938. But neither his noble visions nor the higher aspirations of his Czech brethren can ever be completely obliterated.

We are often deceived because we think too much in material

terms even when questions of religion and culture are involved, which are necessarily immaterial or else a worthless sham. Clever people try to explain history in terms of conflicts between the "have" and the "have not"; if they were not so clever but wiser they would realize that the fundamental cleavage of mankind is not between the "have" and the "have not," but rather between the "give" and the "give not," between the generous and the non-generous. Strangely enough all people agree on that, to some extent at least, when judging the past. They do not inquire what PLATO and ARCHIMEDES "had," or what the Athenians of the golden age "had," they are interested only in knowing what those people "gave." Their gifts, not their possessions, made them immortal. Of course many people, or maybe most people, can only think of what they have, what they had yesterday, what they have to-day, what they will have to-morrow, or the day after to-morrow, or fifty years later, what they might have or ought to have, what their children and grandchildren ought to have, etc. Such people are of course unable to understand what I am saying. In order to understand they should be able to give, to give freely, to give not only out of their surplus but of their own substance, to give not only their possessions but their own selves, yet the poor wretches are unable to give, either because they are intrinsically too poor, or too mean and too "conservative." They don't want to give and they give nothing whatsoever without a struggle; they cling to their possessions as if the latter were more important than life itself; they want to keep as much as possible, rather more than less, and as a result they are doomed to lose everything. Only the things which we have, no matter how passionately we cling to them, can be taken from us, and they are taken away from us by tax collectors of every kind, including the grimmest and most efficient of them all, Father Thanatos, who comes last with his long scythe and is not satisfied with 5 % or 25 % or 90 % but takes all. "The show is over." Nothing whatsoever is left to you except what you managed to save by giving it.

The things which we have may be lost at any time and will vanish in the end; the things which we give, especially if we give them beautifully, are ours forever. That is as plain as daylight for all those who are not fooled by appearances but

can see through them. COMENIUS will live forever because he gave mankind so many treasures which the men of good will will always be ready to appreciate in every clime and at every time. He will be defeated repeatedly and come up again and again, and his fame will grow together with our own fitness for peace and justice and mercy. He cannot be beaten forever, for that would mean that mankind accepted its defeat as final and irremediable, accepted brutality and crime instead of culture,—gave up the struggle and renounced forever its higher aspirations. COMENIUS will live forever not only in the hearts of faithful Bohemians and Moravians, or of the Brethren of Unity—wherever these may be—but also in the hearts of all good men and women.

Bohemia itself will live with her illustrious sons. Her material possessions can be snatched out of her hands but what she *gave* to the world can no longer be taken away from her. I am not thinking now only of COMENIUS—immortal and she herself immortal in him—but of many others. I close my eyes and see the glorious procession. ... ŠTÍTNÝ, MILIČ, MATTHEW OF JANOV, JAN HUS, ŽIŽKA, PETR CHELČICKÝ,... JAN AMOS KOMENSKÝ,... PURKYNĚ,... BEDŘICH SMETANA, ANTONÍN DVOŘÁK, JOSEF SUK, GUSTAV MAHLER (4), TOMÁŠ GARRIGUE MASARYK (5). So many great and good men, but I incline to think, COMENIUS was the greatest of all. I see him pass, holding MASARYK by the hand,—MASARYK, who, when he travelled all over Europe during the war in the interest of Bohemia carried with him everywhere the Kralice Bible and the Testament of the Unity (6). The Unity flourishes, Bohemia is not dead, and when a new

(4) Was GUSTAV MAHLER (1860-1911) a German or a Czech? I am not prepared to say. He was a Jew born in Kalischt, Bohemia, near the Moravian border. He was educated in Iglau (Jihlava) and Prague. Inasmuch as the Germans have repudiated him, we may credit him to the generous Czech nation. See the anti-Semitic number of *Die Musik* (Berlin, March 1936). Anti-Semitism in music! How can anybody stoop as low as that? Congratulations to the editors of *Die Musik*; they have reached the nadir of musical criticism!

(5) For other Czech names see GERALD DRUCE: Czechoslovakia's contributions to science, a survey and a forecast (*Nature* 142, 942-44, Nov. 26, 1938).

(6) "The testament of the Unity, dying mother." A treatise published by COMENIUS in Czech (Leszno, 1650) when the prospects of the Unity were as black as they could be. In it COMENIUS expressed his infinite pain yet his unconquerable hope. The book will remain the best viaticum and consolation for Christian Czechs. It has often been reprinted.

dawn comes (7), COMENIUS will be ready to help in obtaining religious and political peace,—peace and freedom.

Cambridge, Massachusetts GEORGE SARTON.
Christmas Eve, 1938.

NOTES ON THE ILLUSTRATIONS

The twenty illustrations which help us to resurrect for our readers the great personality of COMENIUS have been selected to represent different phases of his immense activity. They are but samples, as it were, but carefully selected, within our possibilities. Indeed, COMENIUS wrote a great many books and some of these are exceedingly rare. For example, I would have liked to illustrate his attack on DESCARTES (Amsterdam, 1659) but it was not available to me though I applied to the seven outstanding Dutch libraries.

I beg to acknowledge the courtesies of the following institutions, either for information or for the communication of photographs.

Amsterdam.	Rijksmuseum. Fig. 1.
Amsterdam.	University Library.
Brno, Moravia.	Museum. Fig. 17.
Cambridge, Mass.	Harvard Library. Figs. 5, 8, 9.
Groningen.	University Library.
Leiden.	University Library.
London.	British Museum. Figs. 6, 7, 10, 11, 15.
Nijmegen.	University Library.
Paris.	Bibliothèque nationale. Figs. 12, 13.
Prague.	National Library. Figs. 2, 3.
	National Museum. Fig. 18.
	University Library. Fig. 16.
Rotterdam.	City Library.
The Hague.	Royal Library.
Utrecht.	University Library.
Washington.	U.S. Office of Education. Figs. 4, 14.

FIG. 1. Portrait of COMENIUS by JURRIAN OVENS (1623-78), a Dutch painter who became a citizen of Amsterdam in 1657 and whose contemporary fame eclipsed for a time that of REMBRANDT! As OVENS

(7) ... quia post hiemem sequitur aestas, post noctem redit dies, et post tempestatem magna serenitas.

and COMENIUS lived for many years in the same city we may safely assume that this portrait was painted from life and that it is as authentic as any portrait can be.

It is kept in the Rijksmuseum, Amsterdam, thanks to whose courtesy it is here reproduced. It is posterior to the engraved portrait (see below fig. 10) made during COMENIUS' visit to England (1641-42). OVENS' portrait was probably made in or after 1656, when COMENIUS established himself in Amsterdam. He was thus at least 64 years of age; he died at the age of 78.

FIG. 2 (*The labyrinth of the world and paradise of the heart*). Title page of the original Czech edition s.l. 1631, reproduced from the copy in the National Library in Prague. On the photostat the height of the outside frame is 16 cm. Second edition, Amsterdam, 1663, and many more.

That little book was written in December 1623 at Klopota and dedicated to Lord CHARLES, baron of ŽEROTIN, captain of Moravia and protector of the Unity. It is COMENIUS' greatest literary achievement and obtained considerable popularity being translated into many languages. I have used the English version of Count LÜTZOW (London, 1901).

It is a pessimistic description of all the vanities of this world. Happiness is unattainable here but only in the hereafter. After all his tribulations in the labyrinth of the world, the pilgrim is finally received into heaven. The book ends with the Latin words " Gloria in excelsis Deo et in terra pax hominibus bonae voluntatis."

FIG. 3. *Centrum securitatis. To gest, swétlé wymalování...* First edition, Leszno, 1633, in the Czech language. Courtesy of the National Library, Prague. Very small size. The photostat of the title page which we reproduce is about 12 cm. high; this is presumably the size of the original.

This work was composed c. 1625, for in the Latin dedication to the count of Leszno dated 1633 it is stated that it was written eight years earlier. The second edition appeared in Amsterdam, 1663.

According to COMENIUS the world is a wheel and God is at the center. The nearer we are to that " center of security " the safer and more peaceful is our position. This is a Plotinian concept.

FIG. 4. *Didactica magna*. COMENIUS' main pedagogic treatise. Title page of its first edition in the *Didactica opera omnia* (Amsterdam, 1657), from the copy in the U. S. Office of Education, Washington. Courtesy of Miss MARTHA R. MCCABE.

COMENIUS began to work at this treatise c. 1627, that is, before his exile (1628), and worked at it in Leszno, Poland, for many years. It is interesting that he first thought of calling it *Paradisus ecclesiae renascentis* or *Paradisus Bohemiae*, then *Didactica*. It was originally written in Czech. In 1635 he began to prepare the Latin translation entitled *Didactica magna*. See the rest of the programmatic title in our facsimile. The Latin edition of 1657 was the first in any language, but since then the work has been frequently reprinted (in full or summarized) in German, English, Italian, Polish, Russian, Slovenian and Czech. The Czech text appeared only in 1849, in Prague. I have used the English version of M. W. KEATINGE : *The great didactic* (2 vols., London, 1921-23), vol. 2 contains the text, vol. 1 biographical, historical and critical notes.

FIG. 5. *Naturall philosophie reformed by divine light* (London, 1651). Title-page, from the copy in the Harvard Library, about 14 cm. high.

This is the translation of the *Physicae ad lumen divinum reformatae synopsis*, which COMENIUS completed on Sept. 30, 1632 at Leszno in Poland. Is is the largest of his three scientific works, which do not illustrate the best side of his genius, yet it enjoyed considerable popularity, because of its curious mixture of anti-Aristotelianism and Christianity. It was used as textbook in many universities in the second half of the seventeenth century, e.g., in Harvard College, in New England. The original Latin text appeared in Leipzig, 1633 ; it was reprinted in Amsterdam, 1643, 1645, in Paris, 1647, in Halle, 1702. The most convenient edition is the German-Latin one by JOSEPH REBER (p. 1-455, Giessen, 1896).

The text is preceded by an epigraph taken from the great Spanish humanist JUAN LUIS VIVÈS (1492-1540), by whom COMENIUS was strongly influenced. The English translator is not named.

FIG. 6 and 7. *Conatuum Comenianorum praeludia*, Oxford, 1637. First and second title page of the book which introduced the English public to COMENIUS' pansophy. The letters S. H. in the main title are the initials of the editor, SAMUEL HARTLIB. This HARTLIB, the son of a German merchant and an English mother, had studied in Königsberg and Cambridge, was a friend of MILTON, and a distinguished educator, agriculturist, and philanthropist, deeply concerned for the peace of the church and the advancement of knowledge. He heard of COMENIUS' activities through two young fellows who had been sent to England by the *Unitas fratrum*, and entered into correspondence with COMENIUS. The latter sent him some writings elucidating his philosophy and pedagogy and HARTLIB was so enthusiastic and so anxious to spread the new ideas

that he published them before having obtained the author's permission, adding a preface where these matters were explained. The *Praeludia* were published with the approbation of the University of Oxford and printed by the University Press.

Height of the pages, about 20 cm., the word *Comenianorum* (second line of main title page) measures 116 mm. Courtesy of British Museum.

FIG. 8. *Pansophiae prodromus* (London, 1639). Second and enlarged edition of the *Praeludia* (Oxford, 1637; fig. 6 and 7), with a preface written by HARTLIB and followed by the treatise *Conatuum pansophicorum dilucidatio*.

This second edition was published with COMENIUS' full approval. Both editions increased considerably his European fame. The *Prodromus* was reprinted in Leiden, 1644, and again, under the title *Pansophici libri delineatio*, in the *Opera didactica omnia* (pars i, 403-54, Amsterdam, 1657). Moreover, HARTLIB provided an English version. "*A reformation of schooles*.... Written many yeares agoe in Latin by... COMENIUS, one of the seniours of the exiled church of Moravia, and now upon the request of many translated into English and published by SAMUEL HARTLIB for the general good of this nation" (London, 1642).

The *Prodromus* of 1639 is a little volume, about 15 cm. high. The title page is reproduced from the copy in the Harvard Library.

FIG. 9. *Pansophiae diatyposis*. Meanwhile, COMENIUS had been preparing a new explanation of his "pansophy." He began working at it while he was in London (1641-42) and the book was first printed at Danzig, 1643. I have not seen that first edition, but only the second, Amsterdam, 1645, of which we reproduce the title page from the copy in the Harvard Library. For a translation of that title page, see the next figure.

The *Diatyposis* is a small volume, about 13 cm. high.

FIGS. 10 and 11. *A patterne of universall knowledge*. London, 1651. Translation of the *Pansophiae diatyposis* by JEREMY COLLIER (1650-1726), a Fellow of St. John's, Cambridge (DNB XI, 341). It is a small book; the word *Patterne* measures 76 mm. Thanks to the courtesy of the British Museum we reproduce its title page and the portrait facing it.

That portrait bears the date A° aetat. 50, 1642 and the signature G. GLOVER. GEORGE GLOVER (fl. 1625-50, DNB XXII, 2) was a well known engraver who drew portraits of many celebrities, e.g., old THOMAS PARR. In the little book on COMENIUS published at Prague in 1928, the same portrait appears in frontispiece, but with another date A°

aetat. 60, 1652 (!) and it is ascribed there to the famous Czech engraver VÁCLAV HOLLAR (1607-77). If HOLLAR really engraved the second portrait, he simply copied the earlier one, adding a new date, as if COMENIUS had remained unchanged between 50 and 60 !

FIGS. 12 and 13. *Via lucis* (Amsterdam, 1668). Treatise drafted by COMENIUS in London in 1641-42, but not published until 26 years later when he added a dedication to the Royal Society, dated April 1668. Thanks to the courtesy of the Bibliothèque nationale, Paris, we publish the title page, and the beginning of the dedication to the Royal Society. The members of that Society had their own views on experimental method, and I am afraid could not be favorably impressed by that grandiloquent dedication.

On the photostat which we owe to the kindness of the Service de documentation of the Bibliothèque nationale, the words *via lucis* measure 94 mm.

FIG. 14. *Didactica opera omnia* (Amsterdam, 1657). Magnificent edition of his collected pedagogical works (a folio of about 1000 p. beautifully printed) which COMENIUS prepared at the request of the senate of Amsterdam and which he gratefully dedicated to that great city. At the head of it he published for the first time the *Didactica magna*, on which he had been working many years, from 1627 onward (see fig. 4); this is followed by other treatises written in Bohemia and in Poland (Leszno). The second part of the Opera contains the works written to the order of Sweden from 1642 to 1650 ; the third, those written at Sárospatak, Hungary, from 1650 to 1654 ; the fourth, eight treatises composed in Amsterdam.

Thanks to the courtesy of the United States Office of Education and of its associate librarian, Miss MARTHA R. MCCABE, we are able to publish the title page of that splendid volume, including a portrait of the author and seven scenes symbolizing his various activities.

FIG. 15. *Disquisitiones de caloris et frigoris natura* (Amsterdam, 1659). Second edition Jena, 1678.

There is a dedication dated Jan. 17, 1659, to Dr. ARNOLD SENGUERD of Amsterdam (1610-67), a famous professor of philosophy with whom COMENIUS became acquainted during his stay in Amsterdam. The epigraph is taken from FRANCESCO SANCHEZ, Portuguese Jew (born at Braga, 1562, died Toulouse 1632), physician and philosopher.

Title page from the copy in the British Museum ; the word *Caloris* measures 56 mm.

COMENIUS wrote three works which may be called " scientific " if that word is sufficiently stretched. The main one, *Physicae synopsis* (1633) is represented by the title page of its English translation (fig. 5); the second *De caloris natura* (1659) we have just dealt with; the third, *Cartesius cum sua naturali philosophia a mechanicis eversus* (1659) is a violent and conceited attack on Cartesianism dedicated " ad Gallos et Belgas," i.e., to the people of France and the Low Countries. COMENIUS had had a long talk with DESCARTES at Endegeest near Leiden in October 1642. As he described it himself many years later (8) :

" We exchanged speech for about four hours, he expounding to us the mysteries of his philosophy, I myself maintaining all human knowledge, such as derives from the senses alone and reasonings thereon to be imperfect and defective. We parted in friendly fashion : I begging him to publish the principles of his philosophy (which principles were published the year following), and he similarly urging me to mature my own thoughts, adding this maxim : ' Beyond the things that appertain to philosophy I go not, mine therefore is that only in part, whereof yours is the whole '."

Clearly these two men equally dogmatic, but the one a rationalist and the other a mystic, could not understand each other.

These three scientific works can be studied most conveniently in the Latin-German edition by JOSEPH REBER (Giessen, 1896), well annotated and well indexed. The Latin and German texts of each treatise occupy respectively 455 p., 51 p., and 23 p.

FIG. 16. *De rerum humanarum emendatione*. Anonymous publication Amsterdam, 1666. This is the general title page, courtesy of the University of Prague. It is divided into two parts called respectively *Panegersia* and *Panaugia* (see their title pages in HEYBERGER, p. 188). That edition of 1666 is exceedingly rare (2 copies known). Second edition of the *Panegersia*, Halle, 1702.

According to HEYBERGER the text was written by COMENIUS in 1644-45. In the photostat received from Prague and which is here reproduced the word *Consultatio* measures 79 mm.

FIG. 17. *Angelus pacis* (Amsterdam, 1667). Appeal for peace addressed to the English and Dutch envoys to the conference of Breda in May 1667. The treaties of Breda concluded July 21, 1667 between England, Holland, France and Denmark were largely concerned with the distribution of the West Indies. COMENIUS beseeched the European

(8) In the *Continuatio admonitionis fraternae* (Amsterdam, 1669) addressed by COMENIUS to his opponent SAMUEL DESMARETS (1599-1673), professor in Groningen. I quote from YOUNG's translation (p. 50).

powers to unite their efforts for the sake of the religious and scientific education of the West Indians. When it is our privilege to travel across those bewitching islands, we should remember COMENIUS' generous plea of 1667 and think how much has been done, and left undone, since that time, three centuries ago.

Printed at Amsterdam, May 1667. Reproduced from the single extant copy in the Museum of Brno, Moravia.

FIG. 18. *Unum necessarium* (Amsterdam, 1668). As indicated on the title page this book was written by COMENIUS at the age of 77, that is not long before his death (aet. 78, 1670). It is dedicated to prince RUPERT (1619-82), eldest son of the ex-king of Bohemia, FREDERIC, the so-called "Winter king," and deals with "the one thing which it is necessary to know" for the sake of life and death and the hereafter, "The art above all arts is to die well."

It was printed in Amsterdam immediately after being written, and was often reprinted in Latin as well as in German and Czech translations. The title page is reproduced from the copy in the National Museum, Prague.

N.B. FIG. 17 and 18 were actually reproduced from the book of ANNA HEYBERGER : COMENIUS (Paris, 1928). At the time of publication of that book she was professor at Coe College, Cedar Rapids, Iowa. I wrote to her, to that address, but received no answer ; she is probably dead.

FIGS. 19 and 20. *Triertium catholicum*. Printed posthumously at Leiden 1681 by the care of COMENIUS' son, DANIEL, and more so of CHRISTIAN VLADISLAV NIGRIN, a brother of the Unity who studied in Oxford. The *Triertium catholicum* was a continuation of the *Janua rerum*, a textbook on metaphysics for children, at which COMENIUS had been working for many years. In fact, the printing of the *Janua rerum* was begun at Leszno in 1649 (10 pages which are lost). It was finally printed posthumously in Leiden, 1681, *Janua rerum reserata hoc est sapientia prima quam vulgo Metaphysicam vocant...* In the *Triertium catholicum* that metaphysics was applied to the needs of life, to the regeneration of mankind. The *Janua rerum* and the *Triertium catholicum* constitute a kind of culmination of COMENIUS' thought, illustrating at one and the same time his philosophical weakness and his pedagogical strength.

The *Triertium* was dedicated at the end of August 1670, that is, about six weeks before the author's death, to the magistrates of Amsterdam, the generous city where COMENIUS had been permitted to spend in relative peace the last years of his life.

We give the title page and the characteristic diagram printed on the verso, both borrowed from the complete facsimile reproduction of the only extant copy preserved in the Premonstratensian monastery of Mt. Sion, Strahov, near Prague. That facsimile (124 p.) was published and introduced (v p.) by GEORGE V. KLIMA and L. ZELENKA LERANDO (Prague, 1922). Courtesy of Harvard Library.

The diagram, as well as the synoptic tables and symmetrical expressions which COMENIUS loved to use, illustrate a mode of his thought, which he shared with many other men such as RAYMOND LULL, AUGUSTE COMTE (see *Isis* 13, 103-05, 1 pl., 1929) and Sir PATRICK GEDDES. Diagrammatic thinking is useful but not so deep and creative, as those men were led to believe.

Labirynt Swěta.
a
Lusthauz Srdce.
to gest
Mětlc Wymalo-
wanj, kterak w tom Smrtel. a wěcech
geho wssech nic nenj než Matenj a Mo-
tanj. Kolocanj a Lopocowanj. Mámenj a Ssalba. Bjda a Teſknoſt / a napoſledy Omrzenj wſſeho
a zawſſánj: Ale kdoż doma w ſwém ſrdci, o gedinym Pánem Bohem ſe vzawjrá / ten sám k
prawému a plnému myſli vpokogenj a radoſti ze pěl-
chářy
M. G. C.
Ex libris Ioannis Ecclesiæ [illegible]
Widěl ſem wſſecky ſtvrky kterýž ſe dějí podſlunečnem / a ag
wſſecko geſt Marnoſt a trápenj ducha.
Léta Kryſtowa M. D C. XXXI.

Fig. 2. — The Labyrinth of the World, 1631. Comenius' main literary work; written in 1623.

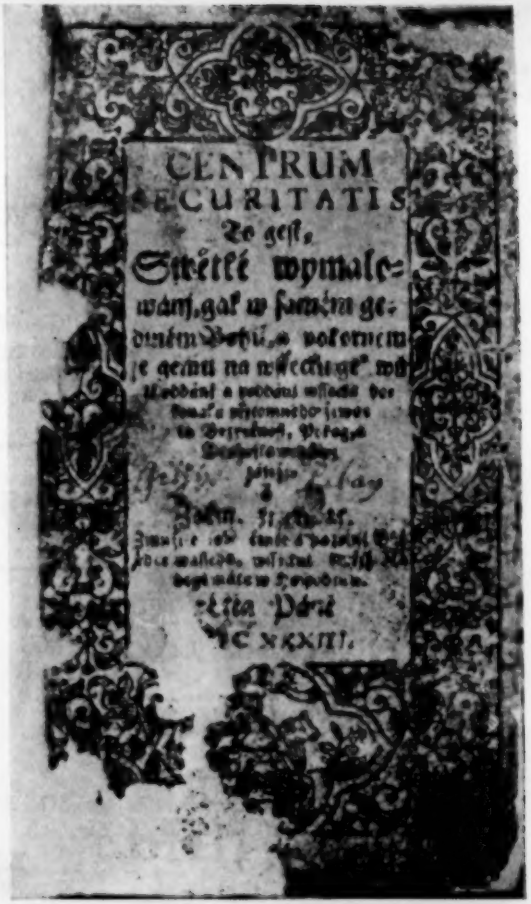

CENTRUM
SECURITATIS
To geſt,
Smětké wymale-
wanj, gak w ſamém ge-
dinem Bohu, a pokogem
ſe gemu na wſſecky ge wd
Wroddánj a podanj wſſudy per
ſwaté ſpjsmo
Léta Páně
M C XXXII.

Fig. 3. — *Centrum securitatis*, Leszno, 1633.

DIDACTICA MAGNA
UNIVERSALE OMNES OMNIA

docendi-artificium exhibens:

SIVE

Certus & exquisitus modus, per omnes alicujus Christiani Regni communitates, Oppida & Vicos, tales erigendi Scholas, ut Omnis utriusque sexus Juventus, nemine usquam neglectô, Literis informari, Moribus expoliri, Pietate imbui, eâque ratione intra pubertatis annos ad omnia quæ præsentis & futuræ Vitæ sunt, instrui possit,

Compendiose, Jucundè, Solidè.

Ubi omnium quæ svadentur,

FUNDAMENTA, ex ipsissima Rerum natura eruuntur.
VERITAS, artium Mechanicarum parallelis exemplis demonstratur:
SERIES, per Annos, Menses, Dies, Horas, disponitur:
VIA deniqve in effectum hæc feliciter deducendi, facilis & certa ostenditur.

FIG. 4. — *Didactica magna*. First printed, in Latin, in the *Didactica opera omnia* (Amsterdam, 1657), but composed in Czech many years before (1627-35).

NATURALL
PHILOSOPHIE REFORMED
BY
DIVINE LIGHT:
OR,
A SYNOPSIS of Physicks:
BY
J. A. COMENIUS:

Exposed
To the censure of those that are lovers of LEARNING, and desire to be taught of GOD
Being a view of the *WORLD* in generall, and of the particular *Creatures* therein conteined; grounded upon *Scripture Principles*.
With a briefe APPENDIX touching the *Diseases* of the *Body*, *Mind*, and *Soul*; with their generall *Remedies*.
By the same AUTHOR.

LONDON.
Printed by *Robert* and *William Leybourn*, for *Thomas Pierrepont*, at the *Sun* in *Pauls* Church-yard, *MDCLI*.

FIG. 5. — *Naturall philosophie* (London, 1651.) Translation of COMENIUS' main scientific work first printed in Latin, Leipzig, 1633.

CONATVVM f132
COMENIANORVM
PRAELVDIA
EX BIBLIOTHECA *S. H.*

OXONIÆ,
Excudebat GUILIELMUS TURNERUS
Academiæ Typographus.
ANNO M.DC. XXXVII.

FIG. 6. — HARTLIB's publication which introduced the English public to COMENIUS' philosophy.

f 132.
PORTA SAPIENTIAE
RESERATA:
SIVE
PANSOPHIÆ CHRISTIANÆ
SEMINARIVM
Hoc eſt,
Nova, compendioſa, & ſolida omnes Scientias & Artes, & quicquid manifeſti vel occulti eſt, quod ingenio humano penetrare, ſolertiæ imitari, linguæ eloqui datur, brevius, verius, melius, quàm hactenus, addiſcendi Methodus.

Auctore
Reverendo Clariſsimóque Viro
Domino *Iohanne Amoſo Comenio.*

Eccl. 3. verſ. 18.
In re magna eque ac parva, ne unam quidem ignorare.

Cicero Epiſt. ad Art. ex Phoc.
τὸν γνωσιμαχον ὁ πᾶς τοῦτος.

OXONIÆ,
Ex Officina GUILIELMI TURNERI
Academiæ Typographi M.DC.XXXVII.

FIG. 7. — Second title page of the same work. Oxford, 1637.

REVERENDI ET CLARISSIMI
VIRI
JOHANNIS AMOS
COMENII
PANSOPHIÆ PRODROMVS,

In quo admirandi illius & vere incomparabilis Operis, Neceſſitas, Poſſibilitas, Utilitas, ſolide, perſpicue, & elegantèr demonſtratur.

Ei, quæ nova hac editione acceſſerint, indicat præfatio S. H. & proxima poſt eam pagina.

LONDINI,
Typis M. F. Sumptibus L. FAWNE, & S. GELLIBRAND,
M. DC. XXXIX.

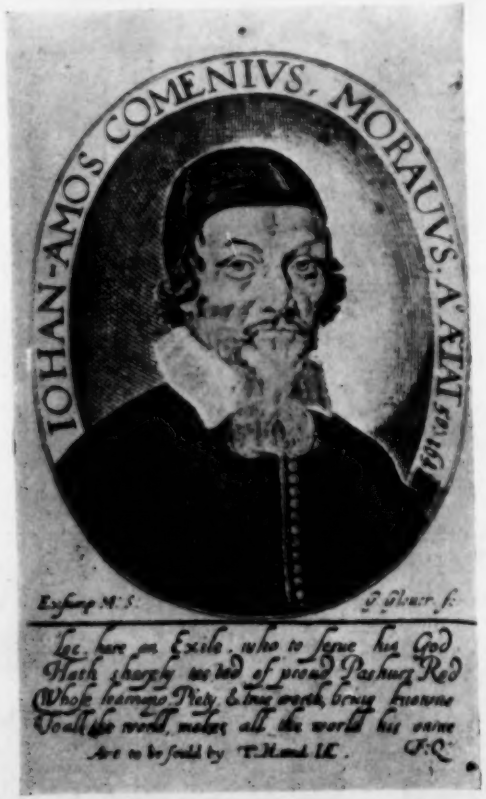
Vœnit in cœmiterio Paulino ſub ſigno ſerpentis ænei.

FIG. 8. — *Pansophiae prodromus*. London, 1639 (Second edition of the *Praeludia*, 1637.)

J. A. COMENII
PANSOPHIÆ
DIATYPOSIS,
ICHNOGRAPHICA
& Orthographicâ delineatione
Totius futuri Operis amplitudinem, dimenſionem, uſus, adumbrans.

Amſterodami,
Apud Ludovicum Elzevirium,
M. DC. XLV.

FIG. 9. — *Pansophiae diatyposis*. First ed. Danzig, 1643. This is the second edition, Amsterdam, 1645.


IOHAN-AMOS COMENIVS. MORAVVS. A'ETAT. 50
Exsimp. M:S.
P. Glover. f:
See, here an Exile, who to serve his God
Hath sharply tasted of proud Pashurs Rod
Whose learned Piety, & true worth, bring knowne
To all the world, makes all the world his owne
Are to be sold by T. Hunt. LL. F.C.

A

PATTERNE

OF

Universall Knowledge,

In a plaine and true Draught :

OR A

DIATYPOSIS,

Or Model of the Eminently Learned, and Pious Promoter of Science in generall,

Mr. *John Amos Comenius.*

Shadowing forth the largeneſſe, dimenſion, and uſe of the intended Worke,

IN AN

ICHNOGRAPHICALL

AND

Orthographicall Delineation.

Tranſlated into Engliſh, by *Jeremy Collier*, Mr. of Arts, late Fellow of St. *Johns* Colledge in *Cambridge*.

London, Printed by *T. H.* and are to be ſold by THOMAS COLLENS, Book-ſeller in Notthampton, 1651. *Novemb.* 25

FIGS. 10-11. English translation of the *Diatyposis* (London, 1651) with COMENIUS' portrait at 50.

VIA LUCIS,
Veſtigata & veſtiganda,
h. e.

Rationabilis disqviſitio, qvibus modis intellectualis Animorum LUX, SAPIENTIA, per omnes Omnium Hominum mentes, & gentes, jam tandem ſub Mundi veſperam feliciter ſpargi poſſit.

Libellus ante annos viginti ſex in Anglia ſcriptus, nunc demum typis exſcriptus & in Angliam remiſſus,
Anno ſalutis
M. DC. LXVIII.

AMSTERODAMI,

Apud CHRISTOPHORUM CUNRADUM, Typographum. Anno 1668.

FIG. 12. — *Via lucis* (Amsterdam, 1668). Drafted in London, 1641-42.

Illuminati Seculi Phosphoris,
Naſcenti reali Philoſophiæ feliciter obſtetricanti Regiæ Londinenſi SOCIETATI,

Salutem, & proſperos ſucceſſus!

ILLUSTRES VIRI,

Non immeritò de Via Lucis Libellus ad Vos Lucis miniſtros (qvorum in haurienda è profundioribus Veritatis puteis Naturalis Philoſophiæ luce induſtria, per Europam famâ celebrari incipit) mittitur. Ideò etiam, qvia ibi natus ubi LUCEM & VERITATEM venandi promiſſi tatus nobis campus Vobis ceſſit: juxta illud Chriſti, ſuo ſenſu huc adhibendum, *Alii laborarunt, & Vos in eorum labores introiiſtis.* Accipite qvid rei ſit: & qvô fine hæc eò, unde venerunt, remittantur.

2. Qvadraginta circiter anni ſunt, ex qvo cordi meo vota Davidicis ſimilia innaſci voluit Deus, ut clamarem, *Emitte LUCEM & VERITATEM tuam DEUS! ut me ducant & deducant in montem ſanctum tuum, in tabernacula tua* (Pſ. 43. 3.) Idqve occaſione ruinarum Patriæ meæ, Eccleſiarum & Scholarum. Cùm autem mox Bellorum flamma vicina qvoqve Regna, & dehinc Europam, corriperet, omniaqve in Chriſtianitate vaſtitatem minarentur, non aliud magis erat ſolatio, qvàm *antiqvæ de ultima Luce promiſſiones Dei, ſuperaturam eſſe tandem tenebras.* Ubi ſi qvid humanæ cooperationis reqvireretur, non aliud fore cogitabam, qvàm ut Juventus è labyrinthis Mundi eripienda meliùs de omnibus (à primis uſqve fundamentis) informaretur. Eôqve fine *condendum fore Librum aliqvem univerſalem, cujus ductu Mentes hominum ſenſim e tenebris in Lucem promotæ, à ſubingreſſu vagis Opinionibus in unam ſimplicem æternæ Veritatis viam dirigirentur.*

FIG. 13. — Dedication of *Via Lucis* to Royal Society, 1668.

FIG. 14. — COMENIUS' collected works on education. Amsterdam, 1657.

DISQUISITIONES
DE
CALORIS
ET
FRIGORIS
NATURA.

Cujus cognitio vera in reseranda multa naturæ arcana Clavis erit.

In Prodromum novæ editionis Physicæ ad lumen divinum restituendæ,

A J. A. COMENIO
antehac luci datæ.

AMSTELODAMI,
Apud JOANNEM JANSSONIUM.
cIↃ IↃ C LIX.

FIG. 15. — COMENIUS' treatise on heat. Amsterdam, 1659.

DE
RERUM
HUMANARUM
EMENDATIONE
CONSULTATIO
CATHOLICA,

Ad Genus Humanum,

Ante alios verò

Ad Eruditos, Religiosos, Potentes,
EUROPÆ.

FIG. 16. — *De rerum humanarum emendatione.* Amsterdam, 1666.

ANGELUS PACIS

Ad

LEGATOS PACIS

Anglos & Belgas

Bredam Miſſus.

Indeqve ad Omnes Chriſtianos

per Europam,

Et mox ad omnes Populos

per Orbem totum mittendus.

Ut ſe ſiſtant, belligerare deſiſtant, Pacisqve Principi, Chriſto, Pacem Gentibus jam loqvuturo, locum faciant.

Anno M. DC. LXVII. Menſe Majo.

FIG. 17. — *Angelus pacis* (Amsterdam, 1667). Appeal for peace and for the education of the people of the West Indies.

UNUM NECESSARIUM,

Scire qvid ſibi ſit neceſſarium, in Vita & Morte, & poſt Mortem.

Qvod Non-neceſſariis Mundi fatigatus, & ad Unum Neceſſarium ſeſe recipiens, ſenex

J. A. COMENIUS

Anno ætatis ſuæ 77
Mundo expendendum offert.

Tarentius.
Ad omnia ætate ſapimus rectius,

AMSTERODAMI,

Apud CHRISTOPHORUM CUNRADUM,
M DC. LXVIII.

FIG. 18. — *Unum necessarium* (Amsterdam, 1668). How a good Christian prepares for death.

Sapientiæ primæ Uſus

TRIERTIUM CATHOLICUM

APPELLANDUS,

Hoc eſt,

Humanarum Cogitationum, Sermonum,

OPERUM

Scientiam, Artem, Uſum,

APERIENS

CLAVIS TRIUNA:

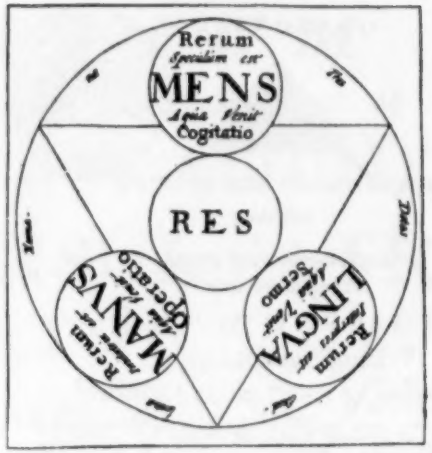
SIVE

Amabile Logicæ, Grammaticæ, Pragmaticæque cum Metaphyſicæ Oſculum.

LUGDUNI BATAVORUM,
Apud Hæredes JACOBI HEENEMAN,
ANNO CIↃ IↃ CLXXXI.

SAPIENTIÆ TRIGONUS

è Rerum Circulo factus.



RES, Mentis ſpeculo exceptæ, dant COGITATIONEM;
COGITATIO, externis ſonis REM figurans dat SERMONEM;
COGITATIO & ſermo in OPUS tranſiens, iterum fit RES;
Et ſic redit in principium ſunm ENS ſeu Eſſe, unde tanquam è fonte ſuo, per Cogitationum, Sermonum, Operationumque rivos effluxerat.

Eundem

FIG. 19-20. — *Triertium catholicum* (Leiden, 1681). COMENIUS' last work written a few weeks before his death, 1670.

BIBLIOGRAPHY

The COMENIUS bibliography is very large in itself, and to it should naturally be added many publications on Czech history and culture, on the *Unitas fratrum*, and on the history of education. Moreover, two periodicals are devoted to COMENIUS and related problems, the *Monatshefte der Comenius Gesellschaft* (Berlin, 1892 ff.), and the *Archiv pro badání o životě a spisech J. A. Komenského* (Archives for research on COMENIUS' life and works, Brno, 1910 ff.). A select bibliography of writings by and on COMENIUS will be found at the end of Miss HEYBERGER's excellent book quoted below (243-65, 1928).

Johannes Amos Comenius : (60 p., Czech Academy of Arts and Literature, Prague 1928). Elegant booklet including articles by the late president T. G. MASARYK, by Prof. ZUBATY and JAN JAKUBEC, published to celebrate the tricentenary of the beginning of COMENIUS' exile.

Anna Heyberger: COMENIUS. Sa vie et son œuvre d'éducateur (Travaux publiés par l'Institut d'études slaves, 290 p., ill., Paris, 1928).

Albert Matthews : COMENIUS and Harvard College (*Publications of the Colonial Society of Massachusetts*, vol. 21, *Transactions*, 1919, p. 146-90, Boston, 1920).

Samuel Eliot Morison : Harvard College in the seventeenth century (2 vols., 1936 ; *Isis* 25, 513-20). Showing that COMENIUS has never been seriously considered for the presidency of Harvard College.

Dorothy Stimson : COMENIUS and the Invisible College (*Isis* 23, 373-88, 1935).

Robert Fitzgibbon Young : COMENIUS and the Indians of New England (27 p., School of Slavonic Studies in the University of London, 1929).

Robert Fitzgibbon Young : COMENIUS in England. (100 p., ill., Oxford, 1932). Containing very interesting synoptic tables illustrating the life of COMENIUS, as well as the history of pansophic ideas.

G. S.

The Universe of De Revolutionibus

As we stand on the threshold of the quatercentenary of the *Narratio Prima* and approach that of the publication of *De Revolutionibus*, it is desirable to re-examine a variety of related conclusions regarding the beliefs and contributions of COPERNICUS. (1) Specifically, it is necessary to call into question the traditional historical interpretations that COPERNICUS believed the stars were attached to a crystal or material shell, that he bounded the world with the Ptolemic eighth sphere, and that either THOMAS DIGGES or GIORDANO BRUNO was the first to " shatter the walls " of the Ptolemaic cosmos and to make the idea of an infinite universe a corollary to the Copernican hypothesis. These traditional interpretations are set forth as follows by such representative and able historians as HARALD HÖFFDING, Sir WILLIAM DAMPIER-WHETHAM, FRANCIS R. JOHNSON, SANFORD V. LARKEY, and A. WOLF :

a) [The Copernican] universe is comprehended within the firm and immovable heaven of the fixed stars, which is its outermost limit. COPERNICUS does not decide whether the world is finite or infinite... This enormous extension of the universe... for COPERNICUS himself... did not indicate any bursting of the old frame... [BRUNO] felt the necessity of going farther than his teacher [COPERNICUS], who, still entangled in ancient and medieval astronomy, adhered to the limitation of the world. (2)

(1) The present essay is based upon a combination of new material and of excerpts drawn from " The Seventeenth-Century Doctrine of a Plurality of Worlds." *Annals of Science*, I (1936), 385-430; " NICOLA(U)S COPERNICUS and an Infinite Universe," *Popular Astronomy*, XLIV (1936), 525-33; " The Eighth Sphere of *De Revolutionibus*," *Annals of Science*, II (1937), 354-6, and pl. XXI; and " Notes on the Spiral Nebulae of Renaissance Cosmological Thought," a paper presented before the joint meeting of the History of Science Society and Section L of the American Association for the Advancement of Science, December 30, 1937, Indianapolis, Indiana.

(2) HARALD HÖFFDING, *A History of Modern Philosophy*, tr. MEYER, London, 1924, I, 107, 112.

b) It is clear that he [COPERNICUS] still accepted the ancient view that the stars were fixed to a sphere at a constant distance from the Earth [*sic*]... BRUNO went further than COPERNICUS and abandoned the old idea that the stars were at a constant and finite distance. (3)

c) THOMAS DIGGES... was the first to advance the idea of an infinite universe as a corollary to the Copernican system... COPERNICUS had been content to retain the eighth sphere of the old system as the outermost boundary of his own, conceiving the fixed stars as located on the surface of this sphere... On the question of the infinity of the universe COPERNICUS refused to take a definite stand. (4)

d) In his diagram of the universe, he [COPERNICUS] was content to portray the position of the stars by a finite, though motionless, circumscribing circle, inclosing the whole world. COPERNICUS, as previously noted, although bringing the question of the infinity of the universe into his refutation of his Aristotelian opponents, had refused to commit himself on the subject. Instead, he had retained in his diagram of the universe the finite sphere of fixed stars... DIGGES, however, clearly perceived... there was no longer any necessity for picturing the stars as attached to a huge rotating sphere at a definite distance from the earth... [He] had the courage to break completely with the older cosmologies by shattering the finite outer wall of the universe. (5)

e) [BRUNO] went further than his master [COPERNICUS] and abandoned the belief that the Stars were fixed to a crystal sphere having the Sun at its Centre. (6)

The initial evidence of the inadequacy of our conventional interpretations is that HÖFFDING, JOHNSON, and LARKEY state on the one hand that COPERNICUS limited or bounded the universe, and on the other that he did not decide whether the universe

(3) SIR WILLIAM DAMPIER-WHETHAM, *A History of Science*, Cambridge, 1932 (and 1929), pp. 122-4.

(4) FRANCIS R. JOHNSON and SANFORD V. LARKEY, "THOMAS DIGGES, the Copernican System, and the Idea of the Infinity of the Universe in 1576," *Huntington Library Bulletin*, V (1934), 69, 72.

(5) FRANCIS R. JOHNSON, *Astronomical Thought in Renaissance England*, Baltimore, 1937, pp. 107, 164.

(6) A. WOLF, *A History of Science, Technology, and Philosophy in the 16th and 17th Centuries*, London, 1935, p. 25.

is finite or infinite. If COPERNICUS regarded the cosmos as limited or bounded, he had decided it was finite. If, on the contrary, he had reached or expressed no decision, it is improper to say that he had bounded the universe. Equally unfortunate is the assertion or patent implication of DAMPIER-WHETHAM, JOHNSON, LARKEY, and WOLF that COPERNICUS conceived the stars as fixed *on* the eighth sphere. None of these historians cite, and I have yet to find any evidence in *De Revolutionibus* which supports this interpretation. Indeed, it remains to be proved that the " benighted " Ptolemists of the sixteenth century regarded the stars as fixed or fastened on a sphere of crystal or of another substance. Ptolemaic astronomies of this century generally described the eight sphere as an extended zone enclosed within an internal concavity and an external convexity. This sphere equalled in depth one-fourth of the diameter of the universe, or about 20,000 semi-diameters of the Earth. (7) An appreciable number of Ptolemaic diagrams, one of which is reproduced by Dr. JOHNSON, depict the fixed stars as located ***within*** the relatively great zone called the eighth sphere. (8) In a nature which " abhorred " a vacuum or empty place there was no need for this extended zone unless, as the diagrams indicate, the fixed stars were placed within, not on the sphere, and at varying distances from the earth. In the complete absence of supporting evidence from *De Revolutionibus*, it is questionable to describe COPERNICUS as holding or setting forth ideas more antiquated than those of the Ptolemists whose system he sought to overthrow.

(7) This distance was usually computed as 65-70,000,000 miles. I cite an extended number of Ptolemaic astronomies which describe the eighth sphere as a zone approximately 65,000,000 miles in depth in "The Astronomy of *Paradise Lost*," *Studies in Philology*, XXXIV (1937), 223, n. 53, and 227, n. 71. The representative *In Astronomicum Joannis de Sacrobosco...* of JACQUES LEFÈVRE (Paris, 1507, I, IX) computes the radius of the eight spheres as 130, 715,000 miles and the depth between concavity and convexity as 65,357,500 miles. The most popular Ptolemaic astronomy of the last two decades of the sixteenth century, the *Commentarius in Sphaeram Ioannis de Sacro Bosco* of CHRISTOPHER CLAVIUS (Rome, 1585, p. 215), gives the depth of the sphere as approximately 81,000,000 miles.

(8) *Op. cit.*, p. 46. Other illustrations can be found in " The Eighth Sphere of *De Revolutionibus*, *loc. cit.*, plate XXI.

I

As a prelude to discussion of the pertinent statements made by COPERNICUS in *De Revolutionibus*, we may recall that sixteenth century religious and astronomical thought normally placed the Heaven of heavens, or the infinite realm of God, the angels, and the elect, almost immediately beyond the bounding convexity of the sphere of the stars. (9) The tenacious hold which this conception had on the minds of educated men is well illustrated by its use in *Paradise Lost* a century and a third after the appearance of *De Revolutionibus* and two decades prior to publication of the *Principia* of NEWTON. MILTON says that his characters :

> pass the planets seven, and pass the fixed,
> And that crystallin sphere whose balance weighs
> The trepidation talked [of], and that first moved;
> And now Saint Peter at Heaven's wicket seems
> To wait them with his keys... (10)

To expand the mundane universe in the sixteenth century was to encroach upon the infinite realm which the age assigned to Deity; to remove its boundary was also to remove the barrier which set apart this universe and the celestial world of God; to remove the boundary and to expand indefinitely the eighth sphere was to bring together in one cosmos both the mundane and the heavenly worlds. An infinite mundane universe left no place for the infinite realm assigned to God. As a canon of the Roman Church, COPERNICUS was well aware that delimitation or extension of the eighth sphere could be interpreted as an invasion of the domain of the angels. He must have known sometime

(9) The ninth heaven or crystalline sphere and the primum mobile, both without any stated depth, separated the convexity of the eighth sphere and the infinite realm of Deity. In the representative Ptolemaic diagram included in the *Cosmography* of PETER APIAN, Antwerp, 1539, fol. 5 (reproduced by Dr. JOHNSON, *op. cit.*, p. 46), the infinite extra-mundane world is described as " the empyreal heaven, the habitation of God and all the elect." As CLAVIUS states (*op. cit.*, p. 45), a number of important Fathers and theologians regarded the empyrean as the happy home of saints and angles. CLAVIUS himself does not attempt to determine whether the realm of God was a part of or was independent of the empyrean, and says (*ibid.*, p. 72) that the realm of God lies beyond the mundane universe, *or*, beyond the empyreal heaven.

(10) *Paradise Lost*, III, 481-5.

prior to his troubled final years that the liberalism which permitted the speculations of NICOLAUS CUSANUS had largely given way to the intolerance fostered by Reformation and counter-Reformation. In short, he might be expected to speak as cautiously regarding the nature and extent of the eighth sphere as effective support of his hypothesis would permit.

In *De Revolutionibus*, I, I-IV, COPERNICUS discusses briefly the conventional topics of the sphericity of the universe, of the earth, and of the movements of heavenly bodies. In the four succeeding chapters he develops and presents his argument for the diurnal rotation of the Earth. The first major point (chapter V) is that our globe is qualified for rotation. He then points out (chapter VI) that heaven is immense in comparison to the earth and has the appearance of an infinite magnitude. As estimated by the senses, he continues, the earth is in respect to heaven as a point to a body, and as a finite to an infinite magnitude. It is astonishing, he declares, that the vast expanse of heaven rather than the earth should be able to turn about in the space of twenty-four hours. Having provided further mathematical proof of the greatness of the universe, and with infinite changed to indefinite, he reiterates the point that heaven is of unmeasurable magnitude in comparison to the earth. It is not known, he declares, how far this immensity (of the heaven) extends itself. In this chapter COPERNICUS nowhere describes the world as bounded by the Ptolemaic eighth sphere, or indeed, as bounded in any fashion.

Having first attacked in chapter VII the Aristotelian conception of gravity, levity, and simple motion, together with the Ptolemaic argument that diurnal rotation of the earth would cause it to fall to pieces, and clouds, birds, and descending stones to move westward, COPERNICUS emphasizes the point in chapter VIII that if rotation would occasion disintegration of the earth, revolution of the far greater heaven would cause it to dissolve into infinity. As its revolution enlarges heaven, he asserts, the swifter must be its motion. In turn, accelerated motion will further increase the immensity of heaven. Thus velocity increases magnitude, and magnitude increases motion, until heaven is extended to infinity. COPERNICUS then introduces the axiom of physics that what is infinite cannot be traversed or moved, and declares that heaven must of necessity stand.

Following this demonstration by dialectic that if heaven moves it is infinite, and if it is infinite it cannot move, COPERNICUS states that " they " say there cannot be physical body, nor place, nor vacuum beyond heaven, and that nothing can go out of heaven. Truly, he observes, it is a marvel, if something may be restrained by nothing. But if heaven is infinite, and only the interior concavity finite, so that all things (*unumquodque*) will be contained in it regardless of the magnitude which they occupy, much more perhaps could it be proved true that nothing lies beyond heaven; but heaven [being infinite or unbounded] will remain immobile. (11) The greatest argument by which they labor to affirm that the world is finite is that it moves *(Nam potissimum, quo astruere nituntur mundum esse finitum, est motus)*. It being certain that in its rotation the spherical earth remains bounded by a confining surface [and does not disintegrate], we therefore may give over the question of whether the universe may be finite or infinite to the disputations of natural philosophers. Why then, COPERNICUS inquires, have we hesitated to grant to the earth the mobility in keeping with its [spherical] form, all for the reason that the world, whose end [*finis*] is unknown and cannot be known, may fall down?

It is first of all apparent that COPERNICUS does not regard the eighth sphere or heaven of the Ptolemists as a crystal or material shell. Equally apparent is the fact that to him heaven, whether bounded or unbounded, is space which contains bodies. He asserts obviously although indirectly his belief that the eighth

(11) In the construction " At si caelum fuerit infinitum... verificabitur " and " fuerit... permanebit," COPERNICUS employs the perfect subjunctive in the protasis and the future indicative in the apodosis. These tenses and moods were not so used in stating pure suppositions or conditions contrary to fact, but in setting forth requisite conditions in the dependent clause, and in the principal clause the conclusion or result which follows from them. In his loose translation of this sentence, THOMAS DIGGES (*A Perfit Description...* as reprinted by JOHNSON and LARKEY, *loc. cit.*, p. 91) so interprets the construction : " Yet yf wee would thus confesse that the Heauen were indeede infinite vpwarde, and onely fynyte downewarde in respecte of his sphericall concauitye, Mutch more perhappes might that sayinge be verified, that without Heauen is nothinge, seeinge euerye thinge in respect of the infinitenes thereof had place sufficient within ye same. But then must it [heaven] of necessity remaine immoueable." The *At* which opens this sentence was employed to introduce with emphasis a new point in an argument. It was not used for " casual " comments.

sphere or universe is unbounded *(tunc sane mirum est, si a nihilo potest cohiberi aliquid)*. He definitely indicates that he will accept only the interior concavity which marked the beginning of the eighth sphere, and states in effect that this sphere, or the universe, must be infinite in order to contain all things, whatsoever their magnitude. Nor was this scientifically an idle statement, for the heliocentric hypothesis increased vastly the apparent magnitude of the stars as well as the distance to them. In the words of CHRISTIAN HUYGENS, " COPERNICUS... having ventured to say that the *Magnus Orbis* was but a point in respect of the sphere in which they [the fixed stars] were placed, it was a plain consequence that every one of them that appeared any thing bright must be larger than the path or orbit of the earth." (12) To CHRISTOPHER ROTHMANN, the diameter of a star of the third magnitude equalled that of the annual orbit of the earth. (13)

Not only does COPERNICUS declare in the above passages that an infinite universe is necessary to contain all things, and that if heaven is infinite and all-containing, it then will stand immobile, but he belittles and questions the efforts of his opponents to prove the world finite. ***Astruere nituntur*** : they endeavour, labor, strive, or strain to affirm by (its) motion that the world is finite. After he has made the points that if heaven is all-containing and infinite, it stands immobile, and has disparaged labored attempts to affirm, not to prove, the world is finite, COPERNICUS then states " it being certain that in (its) rotation the spherical earth will not disintegrate, we ***therefore*** may send forth or give over *(igitur... dimittamus)* the question of whether the world is finite or infinite to the disputations of natural philosophers." (14) While these hypothetical philosophers perhaps are disputing the question

(12) *The Celestial Worlds Discover'd*, London, 1698, pp. 144-5. *Cf. De Revolutionibus*, I, x. I discuss the effect of the heliocentric hypothesis on the estimate of the diameters ascribed to the fixed stars in " The Seventeenth-Century Doctrine of a Plurality of Worlds," *loc. cit.*, pp. 406 ff.

(13) *In* TYCHO BRAHE, *Epistolae Astronomicae*, ed. J. L. E. DREYER, *Opera*, VI(1), 216.

(14) It is not unimportant that COPERNICUS employs the present subjunctive, and the verb " dimitto " rather than " trado " : to trade, to give to another interest or right in a thing, or to abandon something to another, as in Ecclesiastes 3. 11, " Mundum tradidit disputationi eorum "; " God hath delivered the world to their disputes."

of the infinity of the universe, COPERNICUS declares forthrightly that the end or limit of the world is not known and cannot be known *(mundus, cuius finis ignoratur scirique nequit)*. (15)

In I, x, COPERNICUS opens his description of the order and situation of the planets with the somewhat cryptic statement that " First and above all is the sphere of the fixed stars, containing itself and all things, and for this reason immobile." It is of course obvious that the sphere of the stars is not regarded as a crystal shell or as a surface to which the stars are attached, but as a body which contains them. The " se ipsam et omnia continens, *ideoque* [my italics] immobilis," taken as a whole, is however difficult to interpret. In Ptolemaic astronomy the sphere of the stars contained itself and all things, but it was not for this reason declared to be immobile. Has COPERNICUS indulged in a bit of ironic nonsense for the benefit of his orthodox contemporaries? HÖFFDING suggests that he considered heaven " the most honourable part of the universe; hence immobility beseems it." (16) But the Ptolemists regarded the sphere of the stars as the noblest part of the mundane cosmos, and ascribed to it motion of incredible swiftness. A partially similar explanation is that COPERNICUS equated the eighth sphere with the most honorable part of the entire cosmos : the immovable realm of infinite space sacred to Deity and the angels (or the immovable empyreal heaven of the angels and saints, and the infinite realm of God which surrounded it). As I point out *infra*, this is basically the interpretation of the Copernican eighth sphere set forth by THOMAS DIGGES in his loose translation of Book I, *De Revolutionibus*.

(15) JOHNSON and LARKEY state (*loc. cit.*, p. 72) that " On the question of the infinity of the universe COPERNICUS refused to take a definite stand, saying, in the words of DIGGES' translation, 'whether the worlde haue his boundes or bee in deede infinite and without boundes, let vs leaue that to be discussed of Philosophers '." Without passing judgment on the question of whether COPERNICUS regarded the universe as finite, indefinite, or infinite, it may be said that unless DIGGES' translation is read against the original, it easily may prove misleading. His translation omits *igitur*, " therefore," or renders it as " but," and by giving " dimitto " as " leave " deprives it of the connotation which distinguishes it from " trado." DIGGES doubtless employed " leave " with the flavor of " permit to be done by another," an important Elizabethan denotation of the word, and if so approximated the meaning apparently intended by COPERNICUS. In his later study (*op. cit.*, pp. 106-7), Mr. JOHNSON follows a somewhat extended quotation from DIGGES' loose translation with a similar conclusion.

(16) *Op. cit.*, I, 107.

A further explanation is that COPERNICUS thought of the containing sphere of the stars as not dissimilar to the absolute space which, in the definition of NEWTON, " remains always ... immovable." (17) Again, as the parallelism of the statements suggests, he may have followed a theory related to that attributed to ANAXAGORAS by ARISTOTLE : " ANAXAGORAS... says that the infinite itself is the cause of its being fixed. This because the infinite is in itself, since nothing else contains it." (18) Unless the thinking of COPERNICUS in I, X, is contradictory to that in I, VIII, any sphere which may be said actually to contain all things must be unbounded, indefinite, or infinite : " If heaven is infinite, and only the interior concavity finite, so that all things will be contained in it regardless of the magnitude which they occupy, much more perhaps could it be proved true that nothing lies beyond heaven. It is a marvel, if bodies (something) can be restrained by nothing."

Prior to discussion of the diagram which COPERNICUS included in *De Revolutionibus*, I, X, we may recall that in Ptolemaic astronomy the eighth sphere was a relatively great zone bounded within by the internal concavity and without by the external convexity. It was customary in Ptolemaic texts to depict both concavity and convexity in the diagrams, and specifically to identify concavity and convexity and state the distance between them. In contrast with the Ptolemaic diagrams, which normally identified the eighth sphere by means of a zone within two circles, the diagram of COPERNICUS identified the sphere by a single line carrying the legend, " Stellarum fixarum sphaera immobilis." Since the sixteenth century Ptolemist did not think in such terms, it is questionable if he would have understood this single line to represent a crystal shell or material sphere to which the stars were attached. When he had found in *De Revolutionibus* no reference to a bounding convexity of the eighth sphere, and in addition had met the statement that " nothing " restrains the bodies of heaven, we may doubt if he would regard this unique single line as the external and bounding convexity of the sphere. He would naturally assume that an author who made no attempt to compute the semi-diameter of the universe, and declared that

(17) *Mathematical Principles of Natural Philosophy*, Definitions, scholium (MOTTE translation, New York, 1848, p. 77).

(18) *Physics*, III, 5; 205*a*, 11, 1 ff.

its end or limit is not known and cannot be known, would not include in his diagram a limiting or bounding convexity. In view of COPERNICUS' acceptance of the hypothetical interior concavity of the eighth sphere, the Ptolemist doubtless would conclude that the single line depicted represented this concavity, and that the author had not attempted to diagram the world beyond it.

Our conventional conclusions that COPERNICUS attached the fixed stars to a material shell and retained the Ptolemaic eighth sphere as the boundary of the world are patently unsubstantiated assumptions. It also is apparent that he regarded the heaven of the stars as unbounded, but discussion of these and related questions best follows examination of the interpretations of the Copernican eighth sphere set forth by such informed and competent astronomers as RHETICUS, THOMAS DIGGES, TYCHO BRAHE, WILLIAM GILBERT, JOHN KEPLER, and GIOVANNI BATTISTA RICCIOLI. We may bear in mind the absence in *De Revolutionibus* of a statement that the universe is bounded, and the use by COPERNICUS of only a single line in his diagram of the eighth sphere; his ironic reference to those who strain or labor to affirm the world is finite; his pronouncement that the end or limit of the world is unknown and unknowable; the indirect assertion that heaven is bounded by " nothing "; the statement that if heaven is infinite, it could be demonstrated more adequately that heaven contains all things, and that heaven will stand; together with the final declaration that heaven or the eighth sphere does contain all things and therefore is immobile. It will be pertinent to recall that there exists appreciable evidence to show that at the beginning of the sixteenth century the idea of an infinite universe had evoked considerable interest, and had attained some prestige. (19)

II

In the year 1539 COPERNICUS welcomed at Frauenburg a young professor from the University of Wittenberg, GEORG JOACHIM RHETICUS, who had come to learn of the new hypothesis of the universe. As we know, COPERNICUS discussed his theory with

(19) *Cf.* " The Seventeenth-Century Doctrine of a Plurality of Worlds," *loc. cit.*, pp. 392 ff. and 406 ff.

him, and gave RHETICUS permission both to study *De Revolutionibus* and to compose the summary which appeared under the short title *Narratio Prima*. (20) Because of his ability, his interest in *De Revolutionibus*, and his intimate acquaintance with the book and its author, there are few men of the sixteenth century more competent than RHETICUS to speak regarding the beliefs of COPERNICUS. In his " narrative " to JOHN SCHONER, RHETICUS declared :

When we proceed with my most esteemed preceptor [COPERNICUS], we investigate or inquire into nothing beyond the concavity of the sphere of the stars, except so far as Scripture wishes us to inquire and learn concerning these things. As to whatever things Scripture does not desire we should know regarding whatsoever is placed beyond this concavity, forbidden shall be the way... The world is of such greatness that it cannot be measured [*Immensum... mundum esse*], and is in fact the same as infinity [*vere infinito similem*]. It also is similar to infinity as far as to its concavity... It is sufficiently clear that the orb of the stars is to the highest degree similar to infinity [*orbem stellarum maxime infinito similem esse*]. (21) As was said, the agreed (or appointed) end of the inquiries *(hypothesibus)* of my esteemed preceptor is the orb of the stars. (22)

Although RHETICUS was thoroughly familiar with the term " convexity " as applied to the outer boundary of a sphere, and, following COPERNICUS, employs it in discussing the planets, he says nothing of a convexity enclosing the orb of the stars. He twice refers to the beginning or internal concavity of the eighth sphere, and to this alone. More definite are the statements that the "hypotheses" of COPERNICUS stop with the eighth sphere and the careful explanation that Scripture has been respected. If the sphere of the stars of *De Revolutionibus* differed from this sphere in Ptolemic astronomy only in that its concavity was

(20) *De Libris Revolutionum ad Ioannem Schonerum Narratio Prima* [colophon] Ex musaeo nostro Varmiae, Varmiae, IX. Calendas IX. Calendas Octobris, Anno Domini MDXXXIX.

(21) *Narratio Prima*. " Universi distributio," as reprinted in the Thorn, 1873, edition of *De Revolutionibus*, p. 466. The *Bibliotheca Eliotae*, London, 1559, defines *immensus* as " of such greatnesse that it cannot be measured, passynge all measure, unmeasurable."

(22) *Ed. cit.*, p. 467.

farther removed from the center of the universe, there existed no necessity for this careful explanation. The Ptolemist described as a matter of course the concavity, the convexity, and details of the eighth sphere, and at times the immobile and infinite Heaven of heavens (or the empyrean *and* realm of God) which enclosed it. It was only in describing a system whose eighth sphere or universe was unbounded and indefinite, and could encroach upon the realm assigned to Deity, that a sixteenth century apologist would feel the need of stating explicitly that inquiry or investigation not permitted by Scripture terminated at the concavity of this sphere. As we have observed, RHETICUS regarded the Copernican universe as of such magnitude that it cannot be measured, and in fact the same as (or, similar to) infinity.

In view of RHETICUS' statements that the investigations and " hypotheses " of COPERNICUS stopped with the concavity of the orb of the stars, the single line in his diagram which represents the orb must be regarded as its beginning or internal concavity. The diagram of RHETICUS is precisely the one later employed in *De Revolutionibus*. (23) Unless RHETICUS is quite mistaken in his interpretation of the beliefs of his friend and preceptor, and a single diagram was used in two closely related works to represent two entirely different conceptions, we may say that the unique line of the diagram employed in *De Revolutionibus* depicts the beginning or internal concavity of the sphere of the stars. In so far as the authority of RHETICUS may be accepted, we also may say that COPERNICUS regarded the universe as unmeasurable in extent, and in truth similar to infinity.

The second of the several interpreters of the universe of COPERNICUS, THOMAS DIGGES, was for his day an able scientist, an advocate of the experimental method, and as all recent historians of modern astronomy have stated, the first Englishman to support publicly and whole-heartedly the heliocentric hypothesis. Three years after his sponsorship of the Copernican theory in the *Alae seu Scalae Mathematicae* of 1573, DIGGES summarized, at times expanded, and loosely translated *De Revolutionibus*, Book I, under the title *A Perfit Description of the Caelestiall Orbes according*

(23) These identical diagrams are reproduced in *De Revolutionibus*, Thorn, 1873, pp. 29, 465.

to the most aunciente doctrine of the Pythagoreans, latelye revived by Copernicus. This translation he made available by attaching it as an appendix to various issues of his father's *Prognostication euerlastinge.* (24) In the diagram illustrative of the Copernican system, DIGGES states that the eighth sphere " infinitely vp extendeth hit self in altitvde spherically, and therefore immovable," and in subsequent passages of the text describes it as " the huge infinite immoueable Globe " and " that infinite Orbe immoveable." A further reference largely duplicates the fragment quoted from the legend of the diagram. (25)

In harmony with COPERNICUS and RHETICUS, DIGGES says nothing of the bounding convexity of the eighth sphere, and both refers to the internal concavity and depicts it in his diagram. He goes beyond them in that he states forthrightly and without any protective or other qualifications that the universe or eighth sphere is infinite, and that its stars are scattered throughout infinite space. (26) This infinite eighth sphere is a combination of an unbounded and indefinite or infinite heliocentric universe and the immobile infinite realm assigned to God, the angels, and the elect. In a partially modernized version of DIGGES' descriptions, it is the " orb of stars fixed [which] infinitely up extendeth itself in altitude spherically, and therefore immoveable,

(24) All students of the field are indebted to Drs. JOHNSON and LARKEY for their excellent edition of DIGGES' summary-translation, *loc. cit.*, pp. 78-95, to which edition all citations of *A Perfit Description* refer.

(25) *Loc. cit.*, pp. 78, 81, 87, 88.

(26) In addition to describing the stars as " innumerable " in the diagram of *A Perfit Description*, DIGGES states in the text (*loc. cit.*, pp. 88-9, partially modernized), that " we only behold such [stars] as are in the inferior parts... and as they are higher, so seem they of less and lesser quantity, even till our sight being not able farther to reach or conceive, the *greatest part* [my italics] rest by reason of their wonderful distance invisible unto us." As CHRISTOPHER CLAVIUS notes (*op. cit.*, pp. 149-50), it had been the custom to interpret Genesis 22.17 and similar passages as indirect statements that the stars of heaven are innumerable or infinite. This rigidly orthodox Jesuit accepted the idea of innumerable stars, and suggested they might number approximately one-half million. He further stated that when Scripture spoke of innumerable stars, it could be understood to refer to all the stars which are in heaven, as well as those of the six magnitudes *(Dici etiam potest : Scripturam loqui de omnibus stellis quae in caelo sunt, etiam de illis quae minores sunt quam quae in sex differentiis continentur, quae fortasse innumerabiles sunt).* It is unnecessary to mention that such an interpretation of the number of stars is scarcely compatible with the assumption that the eighth sphere was regarded as a material shell to which the stars were attached.

[and] the palace of felicity garnished with perpetual shining glorious lights innumerable, far excelling our Sun both in quantity and quality—the very court of celestial angels devoid of grief and replenished with perfect endless joy; the habitacle for the elect... [This " infinite place "] may well be thought of [by] us to be the glorious court of the great God." (27)

Some years after the appearance of DIGGES' *A Perfit Description*, CHRISTOPHER ROTHMANN and TYCHO BRAHE engaged in a friendly dispute over the magnitude of the Copernican universe. In this dispute the question of the infinity of the world was definitely introduced, and TYCHO declaimed vigorously against " tam inexhausta distantia " of the Copernican cosmos. He asserted that heaven is finite, although it seems infinite and of incredible magnitude, and maintained that it is absurd to seek to explain this " inexhausta distantia " by postulating Divine Omnipotence. The world is finite, TYCHO declared, and was made finite by God. (28) There would have been little point in TYCHO's attack upon the " tam inexhausta distantia " of the Copernican universe by the argument that the world is finite and was made finite by God had he believed

(27) *Loc. cit.*, pp. 78, 89. HELISAEUS ROESLIN, *De Opere Dei Creationis* [no place or date; Frankfort, 1597], p. 33, describes the supercelestial world of Deity as the home of the pure angels and the elect called by God. CLAVIUS (*op. cit.*, p. 45) cites the belief that the empyrean was the happy home of angels and saints *(felicem angelorum, & Beatorum sedem)*, and *(ibid.*, p. 72) the conception that beyond this mundane universe, or beyond the empyrean, is the infinite space in which God exists in his essence, in which, as theologians assert, He is able if he desires to create *(fabricare)* infinite other worlds.

In supporting their thesis that DIGGES consciously interpolated within his digest of *De Revolutionibus*, I, his own independent belief that the eighth sphere is spatially infinite, and that he was the first to make the idea of an infinite universe a corollary to the Copernican system, JOHNSON and LARKEY (*loc. cit.*, p. 113) present evidence to show that the English astronomer developed this belief largely from scientific premises. They first suggest and discuss at some length the possibility that DIGGES may have derived the idea of infinity attributed to him from observations made with the telescope, but conclude that " the precise reasons which led DIGGES to assert... the universe should be conceived as infinite... must remain forever uncertain," that " we may nevertheless be sure... that in approaching this problem he consistently kept to the scientific point of view," and that " scientific considerations played the decisive part in the formulation of his hypothesis." I regret that I find the antithesis both of empirical data obtained by telescopic observation and of a predominantly scientific point of view in an " infinite " sphere which is the very court of God, the palace of the angels, the home of the elect, and is filled with glorious lights which excel our Sun in quality.

(28) *Opera*, ed. cit., VI(1), 221-2.

this universe was bounded by a shell to which the visible stars are attached.

A fourth astronomer who regarded the eighth sphere of COPERNICUS as unbounded, and in addition described its stars as diffused through space was WILLIAM GILBERT, the most eminent of Elizabethan scientists. He included in the posthumously published *De Mundo nostro Sublunari Nova* a discussion of the Copernican system, and illustrated the system by a diagram which depicts the stars of the eighth sphere as scattered in unbounded space. (29)

(29) Amstelodami, 1651, p. 202. GILBERT's diagram is reproduced in reduced facsimile in "The Eighth Sphere of *De Revolutionibus*," *loc. cit.*, plate XXI. The diagram of KEPLER discussed *infra* is similarly reproduced on this plate. JOHNSON and LARKEY, *loc. cit.*, pp. 115-16, and JOHNSON, *op. cit.*, p. 216 argue that GILBERT's diagram derives from THOMAS DIGGES, is representative of his system rather than that of COPERNICUS, and that the idea of an infinite universe set forth in *De Magnete*, VI, III, was taken bodily from DIGGES: "[It was] DIGGES' plan [of the universe], with the stars at varying distances out to infinity, that became associated in the popular mind with the new heliocentric theory... the diagrams of the universe inserted in GILBERT's posthumous work [*De Mundo nostro...*] and in JOHN WILKINS' books... seem to be derived from the diagram which DIGGES published in 1576 [in *A Perfit Description*]... [GILBERT] adopted without qualification DIGGES' idea that the stars were infinite in number, and located at varying and infinite distances from the center of the universe."

It is the belief of the present writer that JOHNSON and LARKEY have failed to consider adequately the facts that GILBERT nowhere mentions *A Perfit Description*, that he was an honest and for his day a competent astronomer; he read and wrote Latin with ease; he unquestionably was familiar with *De Revolutionibus;* he discusses the Copernican hypothesis in *De Mundo nostro*, and includes with his discussion a diagram illustrative of this hypothesis. It is true, as stated (*loc. cit.*, p. 96) that GILBERT's diagram is "somewhat similar to that of DIGGES," but it is equally true that they differ markedly. The two diagrams are similar in that both follow the Copernican order of the planets and show the fixed stars scattered in unbounded space. They differ in that GILBERT's depicts two magnitudes of stars; DIGGES' but one. GILBERT does not show the concavity of the eighth sphere; DIGGES follows COPERNICUS and RHETICUS and includes it. The figures which represent the Sun and the Earth are noticeably different, and the relative distance between the orbit of Venus and that of Mars is much greater with GILBERT than with DIGGES. Where GILBERT employs five independent lines to describe the orbits of Mercury, Venus, Mars, Jupiter, and Saturn, DIGGES employs the Ptolemaic type of "orb," with a convexity and concavity for each of these planets; three circles for Mercury and Venus, and four for Mars, Jupiter, and Saturn—seven in all. GILBERT says nothing of glorious lights which exceed our Sun in quality, or of angels and the elect who live among them. Indeed, the legends are entirely different. The case presented for GILBERT's indebtedness in *De Magnete* is largely that presented for his indebtedness in *De Mundo nostro*. Had GILBERT taken over bodily conceptions attributed to DIGGES, he would have adopted a heliocentric universe as well as mingled glorious lights and angels. There is in

It also is highly probable that the " infinite " mundane world which GILBERT advocates or supports in the earlier *De Magnete* was to a more than negligible degree influenced by *De Revolutionibus*. In this work, VI, III, GILBERT employed with COPERNICUS the word *ineffabili* in describing the diurnal motion attributed to the Ptolemaic eighth sphere. He said with him that PTOLEMY was over-timid in believing rotation would shatter the earth, and that he should rather have feared dissolution of the heavens. Again in the fashion of COPERNICUS, GILBERT declared that " Nature would seem to have given a motion in harmony with the shape of the earth, for the earth being a globe, it is far easier and more fitting that it should revolve on its natural poles, than that the whole universe, whose limit is not known and cannot be known, should be whirled round." GILBERT wrote in this passage, " mundus, cuius finis ignoratur scirique nequit; " COPERNICUS had written in presenting the same argument, " mundus, cuius finis ignoratur scirique nequit." (30)

Among late sixteenth and early seventeenth-century astronomers who regarded the eighth sphere of COPERNICUS as unbounded and unmeasurable in extent, the two most authoritative are JOHN KEPLER and GIOVANNI BATTISTA RICCIOLI. (31) In *De Stella Nova in Pede Serpentarii*, KEPLER stated in passing that Copernican astronomy in particular shows heaven to be " incredibly " high (32),

De Magnete no reference either to DIGGES or to *A Perfit Description*, whereas COPERNICUS is specifically mentioned and drawn upon in VI, III, the section where he is declared to have borrowed from DIGGES.

(30) It is difficult to determine whether GILBERT employed the terms " infinite " and " infinity " relatively and as equivalent to " indefinite," or absolutely. He wrote in VI, III, " How unmeasurable then must be that space which extends to the most remote fixed stars... There cannot be diurnal motion of infinity or of an infinite body, nor therefore of this most greatly extended *(vastissimi) primum mobile*." In neither of these statements does GILBERT say the world is infinite, and in the second he equates " infinity " with *vastissimus*, or, more precisely, with the great but nevertheless finite *primum mobile*. He is wholly in harmony with RHETICUS and COPERNICUS when he describes the eighth sphere as " unmeasurable " in extent.

(31) *Cf.* JULIUS CAESAR LA GALLA, *De Phœnomenis in Orbe Lunae*, Venice, 1612, Chapter VII (GALILEO, LE OPERE, rev. ed., III, 1, 311 ff.).

(32) *Opera Omnia*, ed. CH. FRISCH, II, 688. KEPLER here attacked vigorously the " fixarum infinitas " which he described as advocated and set forth by BRUNO and GILBERT. He declared that belief in an infinite eighth sphere was occasioned by the axiom (that what is infinite cannot be moved) by which ARISTOTLE demonstrates the world to be finite through motion, and COPERNICUS, by removing motion,

and in the *Epitome Astronomiae Copernicanae* illustrated the Copernican hypothesis with a diagram which shows the stars scattered in an unbounded space. (33) This diagram, in keeping with those of COPERNICUS, RHETICUS and DIGGES, depicts the internal concavity of the eighth sphere, and omits the convexity of the Ptolemists. (34) For the wholly adequate reason that " Astronomy teaches no more than that to the extent stars are discerned, space is finite," KEPLER refused to pass judgment on the question of the infinity of the universe. (35)

In Book IX, Section IV, chapter 5, of his *Almagestum Novum*, GIOVANNI RICCIOLI presents and examines in detail ten arguments which had been advanced in support of the diurnal rotation of the earth. The fourth of these arguments is that of the magnitude of the eighth sphere and the physical insignificance of the earth, but in discussing this argument RICCIOLI does not mention

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permits (patiatur) the eighth sphere to be infinite. KEPLER's objections to an infinite universe are religious as well as scientific.

(33) *Ibid.*, VI, 137. This diagram is preceded by one illustrative of the infinite cosmos of " BRUNUS et veterum aliqui."

(34) KEPLER places some few of the stars *on* the concavity. JOHNSON and LARKEY, who do not connect DIGGES and KEPLER, and find DIGGES the source of all early seventeenth-century diagrams of the *Copernican* eighth sphere which show the stars scattered in unbounded space, take the position (*loc. cit.*, p. 97 n. 3) that " The rough sketches printed by KEPLER in his *Epitome Astronomiae Copernicanae* (1618) Bk. I, Pt. 2 (in *Opera*, ed. FRISCH, VI, 136-7), were used solely for the purpose of illustrating his arguments refuting the idea of an infinite universe, which KEPLER credits to BRUNO." The first of these two diagrams depicts an acentric infinite universe with " worlds " scattered at regular intervals, such as BRUNO advocated. As I mention above, it carries the legend, " BRUNUS et veterum aliqui." The second diagram shows an unbounded heliocentric system, and therefore is not illustrative of the hypothesis of BRUNO. Neither does it illustrate the apparently infinite geocentric universe of GILBERT, which KEPLER had challenged in *De Stella Nova*, as cited. In contrast with JOHNSON and LARKEY's conclusion that this second diagram was used by KEPLER in attacking BRUNO's system, which it does not illustrate, and their implication that KEPLER opposed the idea of the indefinite eighth sphere illustrated in the diagram, we may place the comment of CHRISTIAN HUYGENS (*op. cit.*, p. 145) : " KEPLER... in his *Epitome* of COPERNICUS's System... agrees with us, that the Stars are diffus'd through all the vast Profundity." Not only is the second diagram plainly illustrative of KEPLER's interpretation of the Copernican system, but it indeed would be strange for a commentator to include diagrams of two hypotheses which he opposed in passing, and none of the theory whose cause he advocated and whose details he sought to explain.

(35) *Ibid.*, VI, 138.

COPERNICUS. (36) The sixth argument, that of the infinity of the world and of the highest heaven, is introduced by an extended reference to *De Revolutionibus*. Under the side caption, " The discourse of COPERNICUS on the infinity of heaven," RICCIOLI quotes the major portion of the passage from I, VIII, translated in Section I, *supra*. He then observes that the argument from the " uncertainty of the infinity of heaven and the certainty of the finiteness of the earth " is weak, and closes with the comment that prior to this argument there had been set forth what physical mathematicians and not merely physicists teach regarding the infinity of the world. (37) A further and more pointed evaluation states in part that " the hesitant opinion of COPERNICUS... since it is in itself the infinity of the world, or more correctly, the infinite distance of the stars, does not prejudice, and indeed greatly advances the hypothesis of the annual revolution of the earth." (38)

III

The several interpreters of the eighth sphere or universe of COPERNICUS discussed above : RHETICUS, DIGGES, TYCHO, GILBERT, KEPLER, and RICCIOLI all knew *De Revolutionibus* at first hand. They read and wrote Latin, were competent astronomers and mathematicians, and were at home in the background of ideas which nourished COPERNICUS. Of the six men, RHETICUS, DIGGES, and KEPLER advocated the heliocentric hypothesis; TYCHO and RICCIOLI opposed it. GILBERT did not accept the theory, but on the whole was sympathetic toward its claims. With their knowledge, their training, and their diversity of cosmological belief, these men provide an admirable and seemingly authoritative Court of Review.

It is not unimportant that in the works cited none of the six refer to the eighth sphere of COPERNICUS as a material shell, or

(36) Bononiae, 1651, I, II, 314-15.

(37) *Ibid.*, p. 316.

(38) *Ibid.*, p. 317. RICCIOLI previously had stated (*ibid.*, p. 304) that in I, VIII, COPERNICUS declared " the end or boundary of the world *(finem seu mundi terminum)* cannot be known, and therefore that it is impossible to determine whether the universe is finite or infinite," and in III, XV, that the distance between the Sun and the earth is of incalculable smallness in comparison with the immensity of the sphere of the fixed stars.

state that the stars were fixed upon it. Neither do they describe this sphere as that employed by the Ptolemists, nor state that COPERNICUS limited the eighth orb by an external bounding convexity. RHETICUS, DIGGES, and KEPLER depict the internal concavity, nothing more, in the diagrams by which they illustrate the heliocentric theory, and the first declares that COPERNICUS does not extend his " hypotheses " beyond this concavity. DIGGES, GILBERT, and KEPLER show the stars scattered in unbounded space. GEORG RHETICUS states that the world as conceived by his preceptor is of an unmeasurable magnitude, and is in fact the same as (or similar to) infinity. TYCHO attacks the " tam inexhausta distantia " of the Copernican hypothesis with the argument that God made the (mundane) world finite. THOMAS DIGGES, who combined an unbounded and indefinite or infinite mundane world with the infinite realm which his age assigned to Deity and the angels, describes this unique cosmos as the Copernican eighth sphere, and declares forthrightly that it is infinite. RICCIOLI seemingly regarded COPERNICUS as a cautious or hesitant believer in an infinite universe. KEPLER describes the heaven of Copernican astronomy as incredibly high, and GILBERT employs the arguments and words of COPERNICUS in advocating an infinite (or unmeasurable and indefinite) geocentric cosmos.

On the basis of the statements made (and not made) by COPERNICUS in *De Revolutionibus*, and the interpretation of his thought and hypothesis by these able and distinguished men, we are without justification in asserting that he regarded the fixed stars as attached to a crystal (or material) sphere, that he employed the eighth sphere of the Ptolemists, or that he placed a boundary about the universe. His system, as a *system*, extended only to the beginning of the sphere of the stars, so that it was necessary to depict in his diagram only the internal concavity of the sphere. Indeed, he could not honestly have established any second and limiting boundary, for he stated and reiterated the belief that the end of the world is unknown and unknowable. In the thought and system of COPERNICUS the eighth sphere or universe is at the least of unmeasurable magnitude, and its immensity of indefinite extent. Of these things we may be certain.

To argue the question of whether COPERNICUS, or DIGGES,

or BRUNO was the first " to shatter the walls of the Prolemaic universe " is misleading and perhaps somewhat futile. The universe had been regarded as enclosed long before ARISTOTLE and PTOLEMY, and among others NICOLAUS OF CUSA had broken its hypothetical walls before the birth of all these men. (39) We may say however that when COPERNICUS increased to an unmeasurable distance the 65,000,000 miles which the Ptolemist postulated between the concavity of the eighth sphere and the central point of the universe, when he described the cosmos as indefinite in extent, and in addition declared that its end or limit is unknown and unknowable, he scarcely left intact any such hypothetical walls as then were standing. It was of course the evidence provided by the telescope rather than cosmological theory as such which generally dissipated belief in the restricted and bounded Biblical, Aristotelian, and Ptolemaic universe.

It is equally misleading to assert that DIGGES or BRUNO was the first to make the idea of an infinite mundane universe a corollary to the heliocentric hypothesis. BRUNO seems to have transformed a Grecian infinite universe composed of an infinite number of generally enclosed geocentric worlds into one filled with infinite unbounded heliocentric systems. (40) To multiply infinitely unbounded heliocentric systems much as the heterodox Greeks were thought to have multiplied geocentric worlds is scarcely to make the idea of an infinite universe a corollary to the Copernican hypothesis. In presenting what he described as the system of COPERNICUS, the Englishman THOMAS DIGGES combined an unbounded and apparently indefinite heliocentric mundane universe with what may be called the " Ptolemaic " infinite realm of Deity, and produced an infinite eighth sphere which was the court of God, the palace of the angels, the home of the elect, and the *locus* of great lights of seemingly celestial quality. We may say if we wish that DIGGES was the first explicitly to describe the infinite " glorious court of the great God " as a part of the Copernican universe, but scarcely more than this.

The answer which may be returned to the question of whether or not COPERNICUS believed in and made an infinite universe

(39) *Cf.* " The Astronomy of *Paradise Lost*," *loc. cit.*, p. 243; and " The Seventeenth-Century Doctrine of a Plurality of Worlds," *loc. cit.*, pp. 385 ff., 400ff.

(40) *Cf.* " The Seventeenth-Century Doctrine... ", *loc. cit.*, p. 414.

a part of his hypothesis depends in large measure upon the definition given the words " infinite " and " universe." If " infinite universe " properly may mean a cosmos composed of an unbounded, indefinite mundane world which joins with the realm ascribed to God, the statements of RHETICUS and DIGGES suggest the possibility that COPERNICUS believed in a (composite) infinite universe. (41) If the words denote the absolute spatial infinity of a mundane cosmos, the answer probably should be in the negative. The conception was not without importance during the early sixteenth century, and in portions of *De Revolutionibus* (I, VIII and X), COPERNICUS may be regarded as indirectly accepting and using the idea of this type of infinite universe. Because of the conditions discussed in the initial paragraph of Section I, *supra*, this indirect acceptance and use may indicate caution rather than scientific doubt. However, the average of his statements suggests belief in a world which was virtually but not absolutely infinite. The friend and student best qualified to speak for him, GEORG JOACHIM RHETICUS, wrote : " Immensum... mundum esse et vere infinito similem." If the word " universe " refers to a mundane cosmos, and the term " infinite " is employed with one of its sixteenth-century meanings, that of unmeasurable *(immensus)*, or with the modern interpretation of unmeasurable, indefinitely extended, and without conceivable bounds in magnitude, we may say that COPERNICUS believed in and made an infinite universe a part of his hypothesis. Such an infinite universe is the cosmos as it is known and has been known to scientific astronomy : " Mundus cuius finis ignoratur scirique nequit."

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(41) RHETICUS apparently so interpreted the Copernican cosmos when he emphasized the points that the investigations and " hypotheses " of his preceptor stopped with the concavity of the eighth sphere, and, that inquiry had been forbidden " as to whatever things Scripture does not desire we should know regarding whatsoever is placed beyond the concavity." If RHETICUS considered the eighth sphere of his friend and preceptor the purely mundane sphere of the Ptolemist, there was no need for offering such an explanation. This interpretation does not imply that RHETICUS believed, as DIGGES later declared, that the Copernican eighth sphere was a mixture of the mundane and the celestial. The two " worlds " could be a part of one infinite universe and remain independent.

Thomas Robie (1689-1729), Colonial Scientist and Physician

THOMAS ROBIE, " ... the most famous New Englander in science in his day..." (1), was born in Boston on March 20, 1688/89. Although his parents were members of a worthy and respectable class, they were not outstanding individuals. The exact character of ROBIE's early schooling is unknown, but it was sufficient to enable him to enter Harvard with the class of 1708. His behavior in college was that of an average boy (2), and he must have been considered a deserving student, since the grant of forty shillings which the Harvard Corporation voted him on August 22, 1705 (3) was only the first of three awards which ROBIE received while he was an undergraduate.

After he had graduated in 1708, ROBIE taught school in Watertown, Massachusetts for a half year, and then returned to Boston. Like many Harvard graduates of the seventeenth and early eighteenth centuries, he now began to utilize the scientific training which he had received in college by preparing an almanac for the year 1709 (4). ROBIE continued to publish these annual almanacs until 1720. On July 4, 1711, he took his second Harvard degree, that of Master of Arts, and once again the college gave him financial aid when, a month and a half later, the Corporation allowed ROBIE five pounds from the Keayne legacy. He apparently maintained a close if unofficial relationship to the college, and on September 9, 1712, he was voted both the Harvard " Library-

(1) C. K. SHIPTON, *Sibley's Harvard Graduates. Biographical Sketches of Those Who Attended Harvard College in the Classes* 1701-1712 (Boston : Massachusetts Historical Society, 1937), V. p. 452.

(2) *Ibid.*, p. 450.

(3) *Harvard College Records* [Boston : Colonial Society of Massachusetts, 1925-35], (Publications of the Colonial Society of Massachusetts, Volumes XV-XVI, XXI, Collections), I, p. 374.

(4) THOMAS ROBIE, *An Ephemeris... for the Year...* 1709 (Boston : [1708]).

keeper" and a Scholar of the House (5), positions which he held for the academic year 1712/13. As a further mark of approbation, the Harvard Corporation, on April 7, 1713, elected him a "Fellow of the House," as the Harvard Tutors were officially designated. He was also made a Fellow of the Harvard Corporation in July, 1722, but he resigned from both this position and his tutorship the following year when he moved to Salem.

ROBIE is known as one of Harvard's "scientific tutors," but his interests included many subjects in addition to science and the practise of medicine. The notes in his MS Commonplace Book (6) range from excerpts taken from FRANCO BURGERSDIJCK's *Institutionum Logicarum* to the more personal subject of the ethics of sexual relationships. A sampling of the non-scientific contents of this book reveals the following: "Several Opinions of Predestination," an "Alphabet of Prophetick Iconisms," notes on HUGO GROTIUS' *De Jure Belli ac Pacis* and, in particular, many observations on theological and biblical subjects. He had, in fact, seriously considered entering the ministry before his appointment to a tutorship in 1713, and to this end had preached on trial in several towns (7). While he was in Cambridge he continued to preach, at least one of his sermons having been published (8).

ROBIE's scientific interests led him for the most part into the fields of meteorology, astronomy, and medicine. He corresponded with MATTHEW WRIGHT of Crew and with the Reverend WILLIAM DERHAM about various astronomical and meteorological subjects; it was at the latter's request that he kept a meteorological record of Cambridge weather conditions for the years 1715 through 1722 (9). After ROBIE's death in 1729, ISAAC GREENWOOD sent this material to DERHAM, who published parts of it with his own conclusions (10).

(5) *Harvard College Records*, II, p. 405.

(6) At the Massachusetts Historical Society.

(7) SHIPTON, *op. cit.*, p. 451.

(8) THOMAS ROBIE, *A Sermon Preached in the College at Cambridge* (Boston: Printed by S. KNEELAND, 1721).

(9) WILLIAM DERHAM, "An Abstract of the Meteorological Diaries Communicated to the Royal Society," Royal Society, *Philosophical Transactions*, XXXVII (1732), p. 266.

(10) *Ibid.*, pp. 261-73.

As a meteorologist, ROBIE was not only an observer, but also a theorist in the sense that he sought in the works of others for explanations for the phenomena observed. Some of the results of these searchings he published in his *Almanack* for the year 1716. First there is an exposition on " Why it is Hottest in Summer when the Sun is vastly furthest from us; And Coldest in Winter when it is nearest " which he obtained from the footnote on pages 87-89 of DERHAM's *Astro-Theology* (11). Following this there is a discussion on thunder, lightning, and hail. The basis of his explanations of these phenomena he found in COTTON MATHER's *Christian Philosopher*, and in JOHN WALLIS' paper in the Transactions of the Royal Society (12). MATHER suggested that lightning is the result of the vaporization and burning of combustible liquids in the earth, making an analogy to mine explosions. A similar analogy, that of the explosion of gunpowder, suggested to WALLIS that lightning was the burning of nitrous and sulphureous vapours in the air, the nitrous vapour causing the great explosion and the sulphureous the smell. It is interesting to note that FRANKLIN's hypothesis, which he was subsequently able to prove correct, was arrived at by exactly the same method : namely, by analogy to an electric spark.

In ROBIE's work there is, of course, no conception of lightning as an electrical phenomenon, and the two hypotheses which ROBIE selected for an explanation of thunder and lightning were later shown to be incorrect. Nevertheless, he did choose hypotheses which had been obtained by the method of analogy; and he did show, in recognizing the validity of the hypotheses put forth by MATHER and WALLIS, a thorough understanding of the scientific method.

Springs, wind and rain also attracted ROBIE's curiosity. In his Commonplace Book there is a group of notes entitled " Of Clouds and Rain " which he took from Dr. GARDEN's paper (13).

(11) WILLIAM DERHAM, *Astro-Theology* (London: Printed for W. INNYS, 1715).

(12) JOHN WALLIS, " A Letter... concerning the Generation of Hail, and of Thunder and Lightning...," Royal Society, *Philosophical Transactions*, XIX (1695-97), pp. 653-58.

(13) GEORGE GARDEN, " The Changes of Weather from the Alterations of the Gravity of the Atmosphere," Royal Society, *Philosophical Transactions... Abridged* (London: Printed for ROBERT KNAPLOCK, 1716), II, pp. 118-21. These particular notes appear to have been taken from the abridged edition rather than the original.

He also made references to " Dr. WALLIS in Phylosophical Transactions Abr p 123," a criticism of GARDEN's work. Still another source of ROBIE's meteorological information was THOMAS ROBINSON's *Essay towards a Natural History of Westmorland and Cumberland* (14) from which he obtained material for notes on the subject " Of the Original of Wind and Rain."

ROBIE was much more interested in astronomy than meteorology, however, to judge from his correspondence, reading, and publications. He had been instructed in the Copernican system at Harvard, where it had been taught since 1659 and probably earlier (15), but more important still is the fact that he was a Newtonian. Although there is no evidence that he ever read the *Principia*, he learned of the new mechanics from several of the early sources. The *Transactions* of the Royal Society, which were available to ROBIE, contained many Newtonian papers, and he considered at least one of them important enough to record in his Commonplace Book. His copy of HALLEY's article on tides (16) is so letter-perfect and the reproductions of the illustrations so photographic that it is certain that ROBIE used the original printing and not one of the later abridgments. As is evident from the title, this paper is an abstract of NEWTON's work. Another source of ROBIE's knowledge of Newtonian dynamics was WILLIAM DERHAM's *Astro-Theology* mentioned above. Chapter III in the sixth Book of this work is entitled " Of the Power and Usefulness of Gravity to retain the Planets within their Orbits," and DERHAM's discussion of this subject " ... is grounded upon the supposition of the truth of the Newtonian Philosophy..." (17).

ROBIE's Commonplace Book reveals that he had used at least two other important Newtonian works. The first of these two books was JOHN KEILL's *Introductio ad Veram Physicam*, on which he took extensive notes. An ardent Newtonian, KEILL was

(14) (London : Printed by J. L. for W. FREEMAN, 1709).

(15) S. E. MORISON, *Harvard College in the Seventeenth Century* (Cambridge, Mass. : Harvard University Press, 1936), I, p. 216.

(16) EDMUND HALLEY, " The true Theory of the Tides, extracted from that admired Treatise of Mr. ISAAC NEWTON, Intituled, Philosophiae Naturalis Principia Mathematica," Royal Society, *Philosophical Transactions*, XIX (1695-97), pp. 445-57.

(17) *Op. cit.*, p. 145.

NEWTON's chief protagonist in the controversy with LEIBNITZ and other continental mathematicians over the priority of the invention of the calculus. His book, consiting of the lectures which he gave as Sedleian Professor at Oxford, " ... was generally welcomed as an excellent introduction to the 'Principia' of NEWTON " (18). The second indication in ROBIE's notes of his Newtonian thinking is his praise of the Tables in WILLIAM WHISTON's *Praelectiones Astronomicae*, which he later used to calculate an eclipse of the sun (19). WHISTON was one of the first in the early group of men who popularized NEWTON's theories.

He not only read about the new theories but also accepted and used them. The best illustration of ROBIE's knowledge and use of NEWTON's work is in his *Almanack* for 1720. At the end of this little pamphlet there is an appendix which contains " ... an account of the Solar System, according to COPERNICUS and the Modern Astronomers." In this appendix there are tables of " The Middle Distances of the Planets from the Sun " and of " The Diameter of the Sun and Planets with the Moon " which, ROBIE stated, had been " ... calculated from the latest Observations by Sir ISAAC NEWTON's Rules." Here is definite confirmation of an early Colonial adherent to the new mechanics.

Harvard supplied ROBIE with several pieces of apparatus for astronomical observing. The largest instrument available was an 8-foot telescope, which the college had acquired in 1712. Later, in 1722, THOMAS HOLLIS presented the college with a 24-foot refractor, which ROBIE used to make his observations of the eclipse of the sun in the same year. The evidence of ROBIE's early activity as an observer is found in his Commonplace Book and in his papers, of which extracts were published by WILLIAM DERHAM in the *Transactions* of the Royal Society (20). The Commonplace Book contains copies of parts of three letters from WRIGHT and one from DERHAM which tell of his active interest in astronomical phenomena. Sometime after March, 1715/16

(18) R. E. ANDERSEN, " Keill, John (1671-1721)," *The Dictionary of National Biography* (London : Oxford University Press, H. MILFORD, [1921-22]), X, p. 1198.

(19) THOMAS ROBIE, " For the Entertainment of the Country and the Promoting of Knowledge," *Boston News-Letter*, Nov. 5, 1722, and the *New-England Courant*, No. 67, Nov. 12, 1722.

(20) *Op. cit.*, pp. 269-73.

—the latest date of observations mentioned in the text—ROBIE received his first letter from MATTHEW WRIGHT. In this letter WRIGHT mentioned ROBIE's observations of eclipses on December 6, 1713 and August 20, 1714, and of an immersion of the first satellite of Jupiter. He stated that he had received these observations from DERHAM, to whom ROBIE had apparently sent them; and requested ROBIE to send him any dependable observations, which he would communicate to the Royal Society. He also included his own observations of the immersion and emersion of Jupiter's first satellite. In August, 1717, WRIGHT sent more observations of the eclipses of Jupiter's satellites, and shortly afterward ROBIE received some observations of eclipses which were sent to him by DERHAM. ROBIE was apparently very much interested in Jupiter's satellites, for he had written to WRIGHT on July 23, 1717, asking for tables of the eclipses of the three outermost satellites; these were, of course, the second, third and fourth. Excusing his tardiness, WRIGHT replied to this request in a letter dated " Crew, Sept. 30, 1719," and informed ROBIE that there were no tables of the desired material in print.

Further records of ROBIE's scientific work appear in the *Philosophical Transactions* (21). The first is a note on an earthquake at Salem on February 12, 1715/16. This is followed by notes on observations of the immersions and emersions of the satellites of Jupiter, solar eclipses, southings of the moon, meteors, the aurora borealis, the zodiacal light, an eclipse of the moon on June 28, 1721, and an abstract of his observations on the solar eclipse in 1722.

In the same period ROBIE also published two scientific papers. The first was an eight-page pamphlet (22) in which he described, and gave the natural causes of a meteor which appeared on the night of December 11, 1719. The description which ROBIE gave is not that of a meteor, however, but of a remarkable display of the aurora borealis. He himself suggested that it might have been an aurora, and it undoubtedly was, for there is at least one other record of an observation of the northern lights on this

(21) *Ibid.*

(22) THOMAS ROBIE, *A Letter to a Certain Gentleman Desiring a Particular Account May be Given of a Wonderful Meteor that Appeared in New-England, on Decemb.* 11, 1719, *In the Evening* (Boston : J. FRANKLIN for D. HENCHMAN, 1719).

evening (23). Being a true man of science, ROBIE refused to interpret the dreadful red display in the heavens in terms of divinity or philosophy; instead he explained it by the use of WALLIS' nitrous-sulphureous theories mentioned above. Since the preceding days had been hot and sultry, he concluded that the combustible particles had vaporized from the earth, igniting in some manner to cause the fiery exhibition. He regarded the phenomenon as a perfectly natural one, and expressed an abhorrence toward any prognostications based upon it. Although his scientific interpretation of the aurora borealis would be untenable to-day, his attitude toward it was indeed healthy.

ROBIE's second publication (24), a paper which DERHAM communicated to the Royal Society for him, reveals that he had a considerable knowledge of chemistry. It contains a description and explanation of an abnormally high yield of alkali salt which he obtained when he burned the rotten wood of a white oak tree.

Sometime in early May, 1720, ROBIE wrote a letter to President LEVERETT of Harvard requesting " ... the Income of Mr. THOMAS BRATTLE's gift of £ 200 towards the Maintenance of a Master of Arts skill'd in the Mathematicks &c..." (25). On May 24, 1720, President LEVERETT referred ROBIE's request to the Harvard Corporation, who indicated that they would like to see an account of the mathematical performances mentioned by ROBIE in his letter. Further action on this matter was delayed for nearly a year. His account was evidently satisfactory, however, for on May 2, 1721, " Mr. ROBIE having laid before the Corporation Copys of his Mathematical Observations, particularly Such as he has transmitted to the Learned in England, [the Corporation] Voted, That £ 24 the Income of Mr. THOMAS BRATTLE's Donation for two Years be paid to Mr. ROBIE " (26).

Continuing the independent work for which he had been thus rewarded, ROBIE further pursued his astronomical observations.

(23) JOSEPH LOVERING, *On the Periodicity of the Aurora Borealis* ([Cambridge and Boston] : 1868), [From the Memoirs of the American Academy, New Series, X], p. 245.

(24) THOMAS ROBIE, " An Account of a large Quantity of Alcalious Salt produced by burning rotten Wood," Royal Society, *Philosophical Transactions*, XXXI (1720-21), pp. 121-24.

(25) *Harvard College Records*, II, p. 449.

(26) *Ibid.*, II, p. 458.

His next major investigation in this field was occasioned by the annular solar eclipse on November 27, 1722, which excited him considerably. He had a wonderful new 24-foot telescope with which to make his observations, and he made elaborate arrangements for obtaining as much data as possible. He prepared the people of the Colony for the coming phenomenon by his article " For the Entertainment of the Country and the Promoting of Knowledge " (27), which appeared in at least two Boston newspapers. In this article he described the coming eclipse, the extent of which he had calculated would be eleven and a half digits; he also requested that the " curious " make observations, particularly of the corona, and send them to him. When the sun rose on the morning of November 27th, ROBIE was at the 24-foot telescope and his assistant DANFORTH at the older 8-foot instrument. The event had been so well publicized that most of the members of the college had apparently ascended to the roofs of the buildings, from which vantage point they were able to see the eclipsed sun before ROBIE (28). Unfortunately the sun immediately clouded over, so that ROBIE was unable by observing it at its greatest phase to verify his calculations. When he next saw it an hour later it was eclipsed about six digits, and the moon passed off the face of the sun at 9:25 A.M. Apparently in response to his advertisement, he received several observations from others which enabled him partially to confirm his own calculations of the path of the shadow.

ROBIE resigned from his offices of Tutor and Fellow at Harvard on February 5, 1722/23 (29), and shortly afterward moved to Salem, where he began to practise medicine. SHIPTON points out that the probable reason for this change was ROBIE's marriage to MEHITABLE SEWALL of Salem on January 17, 1722/23 (30).

(27) *Op. cit.*

(28) THOMAS ROBIE, " Part of a Letter... Concerning the Effects of Inoculation; The Eclipse of the Sun in November 1722; And the Venom of Spiders," Royal Society, *Philosophical Transactions*, XXXIII (1724), pp. 67-70. The same notes on this eclipse also appear in an unaddressed letter from ROBIE which was probably sent to Governor WILLIAM BURNET at New York on November 9, 1723. This letter is now in the Cadwallader Colden Papers : New York Historical Society, *Cadwallader Colden Papers* (Collections, 1917, New York : Printed for the Society, 1918), I, pp. 157-59.

(29) *Harvard College Records*, II, p. 479 and p. 483.

(30) *Op. cit.*, p. 453.

o MDCCXVI.

AN

Almanack

OF THE

Cœleſtial Motions, Aſpects, and ECLIPSES,

For the Year of the Chriſtian Æra,

1716.

Being Leap-Year in our Account.

Whereto are Numbred,

From the
- CREATION — 5665
- Diſcovery of *America* — 224
- Settlement of *New-England* — 96
- Planting the *Maſſachuſetts* — 88
- Building of *BOSTON* — 96
- Founding of *Harvard College* — 77

Being the Second Year of the Reign of our moſt Gracious Sovereign Lord King *GEORGE*, which began *Auguſt* 1ſt 1714

Fitted to the Meridian of Boſton *in* N E *being in the Lat. of* 42 deg. 25 min. North, *and about* 71 Degrees *to the* Weſtward *of* London

By **Thomas Robie**, M. A.

Imprimatur, J. DUDLEY

BOSTON Printed by *T. Fleet* and *T. Crump*, for the Bookſellers, and Sold at their Shops 1716

FIG. 1

Title-page of ROBIE'S *Almanack* for 1716 (Courtesy of the Harvard College Library).

And this I ſhall take to be the true Solution of this wonderfull Appearance, 'till ſomebody will give me, or I can find, a better.

As to Prognoſtications from it, I utterly abhor and deteſt 'em all, and look upon theſe to be but the Effect of Ignorance and Fancy; for I have not ſo learned Philoſophy or Divinity, as to be diſmayed at the Signs of Heaven; this would be to act the Part of an Heathen not of a Chriſtian Philoſopher, See *Jer.* 10. 2. And here I would intreat you to take me right, for I don't mean that this Sight was not ſurprizing to me, for I have ſaid it was before, but I only mean that no Man ſhould fright himſelf by ſuppoſing that dreadful things will follow, ſuch as Famine, Sword or Sickneſs; Nor would I be underſtood to imagine, that there will not be fearful Sights in the Heavens before the great and terrible day of the Lord.

Thus, good Sir, I have, as well as I could, given you an account of that unuſual *Meteor*, together with my tho'ts upon it. If it is acceptable to you, I ſhall heartily rejoyce, and allow you to expoſe it as you pleaſe, only concealing my Name; hoping what I have ſaid may ſerve in ſome meaſure to illuſtrate the works of Nature, which all they who have Pleaſure therein will inquire into, that ſo they may be excited to love, honour, and adore the GOD thereof; to whom be Glory for ever. *AMEN.*

Boſton N E 15 Dec. Anno, 1719.

I am, Sir,

Your very Humble Servant,

ΦΙΛΟΣ ΣΟΦΙΑΣ.

Thomas Robie

To Hon. of Harvard College

FIG. 2

Last page of ROBIE'S pamphlet on the so-called meteor (1719). Note his adherence to scientific explanations of natural phenomena and his opposition to superstition (Courtesy of the Boston Public Library)

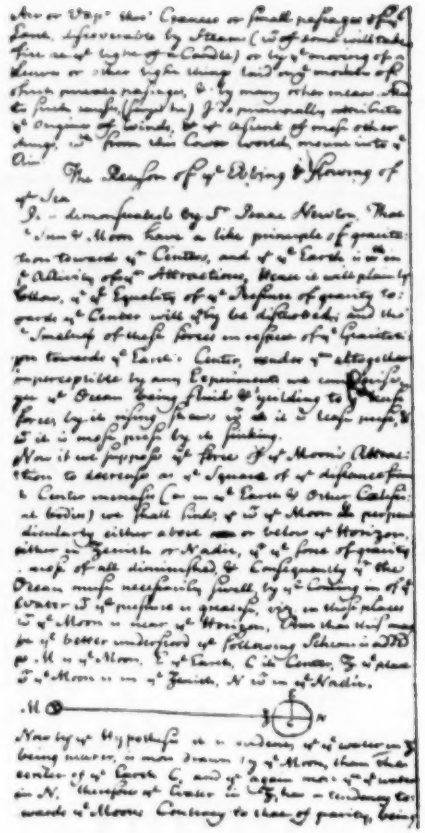

FIG. 3
Part of ROBIE's notes taken from HALLEY's Newtonian article on Tides (Courtesy of the Massachusetts Historical Society). Observe how accurately ROBIE copied the original shown in FIG. 4

force of Gravity towards the Center, would continue in a perfect ſtagnation, always at the ſame height, without ever Ebbing or Flowing; but it being here demonſtrated, that the Sun and Moon have a like Principle of Gravitation towards their Centers, and that the Earth is within the Activity of their Attractions, it will plainly follow, that the Equality of the preſſure of Gravity towards the Center will thereby be diſturbed, and tho' the ſmallneſs of theſe Forces, in reſpect of the Gravitation towards the Earths Center, renders them altogether imperceptible by any Experiments we can deviſe, yet the Ocean being fluid and yielding to the leaſt force, by its riſing ſhews where it is leſs preſt, and where it is more preſt by its ſinking.

Now if we ſuppoſe the force of the Moons attraction to decreaſe as the Square of the Diſtance from its Center increaſes (as in the Earth and other Celeſtial Bodies) we ſhall find, that where the Moon is perpendicularly either above or below the Horizon, either in Zenith or Nadir, there the force of Gravity is moſt of all diminiſhed, and conſequently that there the Ocean muſt neceſſarily ſwell by the coming in of the Water from thoſe parts where the Preſſure is greateſt, *viz.* in thoſe places where the Moon is near the Horizon: but that this may be the better underſtood, I thought it needful to add the following Figure, where *M* is the Moon, *E* the Earth, *C* its Centre, and *Z* the place where the Moon is in the Zenith, *N* where in the Nadir.

Now

FIG. 4
A page of HALLEY's paper on Tides (Op. cit.), which he based on NEWTON's *Principia*. Compare with ROBIE's notes (FIG. 3)

Appendix.

TO fill up the vacant Pages, it may be proper to give an account of the *Solar Syſtem*, according to *Copernicus* and the Modern Aſtronomers.

Copernicus, the Reviver of the ancient *Pythagorean* Hypotheſis, makes not only the *Earth*, but alſo the *Planets*, except the *Moon*, (which turns about the *Earth* in about 27 days & an half) turn about their own Centers, and move round the *Sun* by different Motions peculiar to themſelves, *&c.* *Mercury*, which is neareſt the *Sun* in 3 Months; *Venus* in 7 Months and an half; the *Earth* (which in this *Syſtem* is a *Planet*) in one Year; *Mars* in 2 Years; *Jupiter* in 12 Years; and *Saturn*, which is fartheſt from the *Sun*, in 30 Years. The *Sun* being fixed in the Center of the *Planetary World*, and moving round on its *Axis* in about 26 days; as is proved from the Revolution of certain *Spots* ſeen by the *Teleſcope*, and known to ſuch as have been ſo Curious as to make the Obſervation. The *Moon* is not, by this Hypotheſis, to be reckoned among the Primary *Planets*, but is only an Attendant on the *Earth*, and ſerves as a Satellite to it.

The Excellency of this *Syſtem* is argued from the Plainneſs of it, it being free from thoſe *Epicycles*, which the Old *Ptolemaick* ſuppoſed, in order to account for the Motion of the *Heavenly Bodies*. *Ptolemy* could not account for the Succeſſion of *Night and Day* without forcing the whole *Frame of Nature*, excepting the *Earth*, to revolve in 24 hours, nor for the Changes of the various Seaſons of the Year, without making the *Sun* to go *Eaſt*, when at the ſame time it was with all its might trudging to the *Weſt*: But this Excellent Hypotheſis ſolves all by ſuppoſing only the *Earth* to roll upon its *Axis* from *Weſt* to *Eaſt* in about a Year, advancing daily about 59 *m* 8 *ſec.* of its mean Motion, in a Line croſſing the *Æquator* in an Angle of about 23 *D.* & 29 *M.* And ſo it ſolves all the Stations and Retrogradations of the *Planets*, as I would prove, were there room here to do it.

As to the Extent of this *Syſtem*, the following Tables will give an account of, being Calculated from the lateſt Obſervations by Sir *Iſaac Newton*'s Rules. The

FIG. 5

A page from ROBIE's *Almanack* for 1720 (Courtesy of the Massachusetts Historical Society). Note Robie's use of Newtonian mechanics as revealed in the last sentence

A Journal of ye Inoculation at ye Hospital on Spectacle Isle: Land of Robie.

May 07 1722 To day I came from ye College at Camb. to ye Spectacle Island to visit ye Inoculated Persons hereafter mentioned, who were by ye thing (ye Boston-Mobb. forced down to ye aforesaid Island to go thro ye Operation wch was performed on ye 4th day or two before.

The Names of ye Persons are

Mr J. Jewal & his Wife	aged about	32 Years 29
Mrs Joanna Alford	about	20
Benj. Woodbridg		13
George Howel		[illegible] 10
Nathan Howel		8

18. To day B. Woodbridg & ye two Howels took an Emetic.

19 G. Howel had a small Convulsive Fit, & in ye Morning ye J. Pox appeared.

FIG. 6

First page of the MS Journal which ROBIE kept while he was taking care of those inoculated for smallpox and confined to Spectacle Island (facsimile of the original entered in RECOMPENSE WADSWORTH's Commonplace Book at the Massachusetts Historical Society)

It was not without regret that the Harvard authorities let him go, and President LEVERETT recorded the following in his MS " Book Relating to College Affairs " (31) :

> It ought to be Remembered, That Mr. ROBIE was no small honour to Harvard College, by his Mathematical Performances and by his Correspondence thereupon with Mr. DERHAM & other learned persons in those Studies abroad.

In addition to his meteorological and astronomical studies at Harvard, ROBIE had also acquired by his own diligence a comprehensive knowledge of medicine. It was undoubtedly by teaching himself that he had attained the knowledge which made it possible for him to practise medicine later, as there were no Medical Schools in the Colonies at this time. The usual procedure was to go to some European university, such as Edinburgh, or to serve an apprenticeship to a practising physician. Since only a few young men could afford the expense of a European schooling, most of the Colonial doctors were trained by the apprentice method. It is certain that ROBIE did not obtain any medical instruction abroad, but neither is there evidence that he served as an apprentice to any of the local practitioners.

The one clue to the source of ROBIE's medical education is his Commonplace Book the major part of which consists of notes on medical subjects. Taken from widely divergent sources, some of these notes are extracts from such authorities as THOMAS SYDENHAM (1624-1689), THOMAS WILLIS (1621-1675), and ARCHIBALD PITCAIRNE (1652-1713); some of them are " Medicinal Receipts " from the local townspeople, which were made up of the conglomerations typical of remedies of the period. That this Commonplace Book must have played an important function in ROBIE's practise of medicine may be inferred from the following headings which are representative of ROBIE's notes: " A Catalogue of the Diseases treated of in the Following Pages," " Medicinal Receipts from a mss," " Ad Luem Veneream inveteratam Curandam Saepius Prob." (with the text also in Latin), and " A Catalogue of Diseases and the medicines proper for them."

(31) In the Harvard College Library, p. 252.

ROBIE achieved at least a small right to medical immortality for his work in connection with the smallpox epidemic which broke out in Boston in 1721. Upon the eruption of this dreaded disease, the Reverend COTTON MATHER requested the Boston doctors to use the new treatment of inoculation which had been described in the *Transactions* of the Royal Society (32). All refused but one—ZABDIEL BOYLSTON, who inoculated about 240 people in spite of continuous opposition. Later two other men, Dr. THOMPSON of Roxbury and " Dr. ROBY " of Cambridge, joined BOYLSTON. According to BOYLSTON, THOMPSON performed about twenty-eight operations and ROBIE eleven (33), so that the total number of inoculations was approximately 280. Of this number only six died, giving a mortality of slightly more than 2.1 per cent, in contrast to the 14.9 per cent mortality of all those who contracted the disease. The value of the work done by the inoculators may be more fully appreciated by comparing the inoculation mortality of 2.1 per cent with the 8.5 per cent mortality of the total population.

Notwithstanding this commendable record, the opponents to variolation (and they were legion) were extremely antagonistic, and placed every conceivable obstacle in BOYLSTON's path. Finally after BOYLSTON had inoculated six people on May 11, 1722, the Boston Selectmen forced the inoculated to go down to the isolation hospital on Spectacle Island in Boston Harbor (34). This action was taken on either the 15th or 16th of May, and on the 17th ROBIE followed the inoculated down to the hospital to take care of them. While he was there he kept a journal, which he later entered in RECOMPENSE WADSWORTH's MS Commonplace Book (35) with other case histories. The following is a free transcription of the record of his two-weeks' stay on the island (36) :

(32) R. H. FITZ, *Zabdiel Boylston, Inoculator, and the Epidemic of Smallpox in Boston in* 1721 [Boston (?) : 1911], [From *The Johns Hopkins Hospital Bulletin*, XXII, No. 247, September, 1911], pp. 7-10.

(33) ZABDIEL BOYLSTON, *An Historical Account of the Smallpox Inoculated in New England* (2d ed., cor., Boston : Reprinted for S. GERRISH and T. HANCOCK, 1730), p. 32.

(34) FITZ, *op. cit.*, pp. 24-25.

(35) At the Massachusetts Historical Society.

(36) Printed with the permission of the Massachusetts Historical Society.

A JOURNAL OF THE INOCULATION AT THE HOSPITAL ON SPECTACLE ISLAND

BY

T. ROBIE

May 17, 1722. To-day I went from the College at Cambridge to the Spectacle Island to visit the inoculated persons hereafter mentioned, who were by the fury of the Boston mob, forced down to the aforesaid island to go through the operation which was performed on them a day or two before.

The names of the persons are :

Mr. S. SEWALL	Aged	32	years
and his wife	About	29	»
Mrs. JOANNA ALFORD	About	20	»
BENJ. WOODBRIDGE		13	»
GEORGE HOWEL		10	»
NATHAN HOWEL		8	»

May 18. To-day B. WOODBRIDGE and the two HOWELS took an emetic.

May 19. G. HOWEL had a small convulsive fit, and in the evening the smallpox appeared.

N. HOWEL had a flux which lasted two or three days and then the smallpox came out well. These three boys had but a few pustles and very distinct.

B. WOODBRIDGE by his carelessness got cold and so had a bad sore throat and difficulty of breathing. But by the application of blisters and other means he soon got well.

The boys, as soon as the eruption was complete, played about the house and complained no more except B. WOODBRIDGE as above.

May 20. Mr. SAM SEWALL and wife were vomited on this day and the pox appeared soon after. They both were bled on the night of May 22nd and were very faint and restless.

Mrs. SEWALL had her monthly purgation though it was not the usual time.

They both were very full and very sore, their incisions ran very much, and were very offensive. They each had an anodyne which heated Mr. SEWALL too much but was very agreeable to him, causing him to rest very well, and he continued the use of it till the pox were all turned. Mr. SEWALL spit something considerable.

May 26. This morning Mr. SEWALL was griped pretty much and had a stool very fetid about 4 in the morning, another at 10, and three at 2 P.M., and fearing he would fall into a flux which he is prone to, I gave him

medicines to stop it which succeeded according to my desire and to-day we all allowed the pox to be turning.

Note : I never observed a flux hurt anybody who was bound while the smallpox was coming out and ripening, upon the turn, provided it did not exceed.

Mrs. JOANNA ALFORD was vomited on Tuesday, May 22nd, was faint and tired after it. A few pustles were seen in the skin the day before, on the 23rd they came out full. She was very sore and very restless and very full and fatter than is usual in inoculation, which I attribute to the concern of mind they were under, to the hotness of the season and their keeping them too hot before their decumbiture for fear of taking cold which I could not prevent by all I could say.

Mrs. ALFORD's fever kept up pretty long though not high.

May 24. This night she was very restless and on the 25th they began to turn. She took an anodyne during this night and slept well after it.

Note : Her menses came down also though it was not the time for nearly 9 or 10 days.

N. B. : That I never looked after a woman in the smallpox but she had her menses, let it be the time or not.

June 1. Since the 25th they have been growing better and I left them this day and returned to the College the next. And this is all I can remember about the inoculated at Spectacle Island.

Since my return I hear that Mr. SEWALL was troubled with the strangury etc. but is now well. He came to Boston again in July.

Entered from a loose piece of paper August 14, 1722.

Smallpox took a dreadful toll in the eighteenth century, its repeated epidemics being justly feared by all who had not already had the malady. The Colonies frequently suffered recurrences of this terrifying affection, and it is significant that the first medical publication to be printed in the British Colonies was THOMAS THACHER's *A Brief Rule to Guide the Common People of New-England how to order themselves and theirs in the Small Pocks, or Measles* (Boston : Printed and sold by JOHN FOSTER, 1677) (37). ROBIE understood the importance of being competent in fighting smallpox long before he heard of variolation. He devotes more space in his medical notes to this malady than to any other disease except fevers. His information about smallpox came from several

(37) See complete facsimile of this broadside in *Isis*, XXIII (1935), opposite p. 398, with commentary by HENRY R. VIETS.

sources, including SYDENHAM and ARCHIBALD PITCAIRNE's *Method of Curing the Small Pox written in the year* 1714 *for the use of the Noble and Honourable Family of March.* There is no mention of variolation, however, except in the case histories of his Cambridge smallpox inoculations which are in RECOMPENSE WADSWORTH's Commonplace Book. Since the vast majority of physicians and laymen were bitterly opposed to variolation, ROBIE should be justly given praise for his recognition and use of the new treatment. It was a small but intelligent and courageous part which he played in the first extensive use of inoculation in the Western World.

ROBIE was practising medicine in Cambridge prior to his resignation from Harvard in 1723, and he must have been exceedingly industrious to be able to give medical treatment in addition to performing his scientific investigations and discharging his responsibilities for instruction at the college. A manuscript bill (38) for medical services rendered to President LEVERETT and his household indicates that he was giving treatment before 1723. Although the bill is dated "Salem, Nov. 19, 1725," it reveals that some of the debt for medical care was incurred in 1722 and in January, 1723. ROBIE has also recorded that he was called in consulation on the case of the spider bite in September, 1722, which he later described in the Royal Society's *Transactions* (39).

After ROBIE moved to Salem the practise of medicine became his principal work, but even then he did not give up his former scientific pursuits. Although little is known of ROBIE's life in Salem, his letter to Governor BURNET (40) shows that he continued his astronomical observations, for he described the transit of Mercury, which he had observed at Salem on October 29, 1723, with a nine-foot telescope. He had been eager to determine the presence of an atmosphere around Mercury; he concluded from his observations that there was one, which he judged to be larger in proportion than that of the earth. ROBIE told BURNET that he intended to continue his observing, but if he did so there is no record of it.

(38) In the New York Public Library.
(39) *Op. cit.*, pp. 69-70.
(40) *Op. cit.*, p. 159.

On April 15, 1725, two years after he had moved to Salem, ROBIE was elected a Fellow of the Royal Society (41). He had evidently not heard of this honor by June 7th, for in a letter of this date addressed to JAMES JURIN, the Secretary of the Society, ROBIE did not mention his election. Since he had never corresponded with JURIN before, he certainly would have acknowledged his election if he had known of it. With the exception of his will this letter, now in the archives of the Royal Society, is the latest of the ROBIE documents extant. The letter mentions his meteorological observations, which he sent to JURIN at ISAAC GREENWOOD's suggestion, and concludes with some rather acute remarks on hysteria. From June, 1725, until his death, nothing specific is known of ROBIE's scientific activity. Presumably he continued to practise medicine in Salem, where he died on August 28, 1729. A Boston newspaper's account of his death accurately described him as a " ... Person truly valuable and much esteemed for his Piety Learning and extensive Usefulness, having sustained and faithfully discharged the Duties of several Publick Stations " (42).

The THOMAS ROBIE who left Harvard in 1723 was a different man from the one who had received his A. B. there in 1708. During the fifteen years which followed his graduation he underwent a truly remarkable scientific evolution. He was not exactly alone in a scientific wilderness, but there was no one who could give him instruction more advanced than that which he had received in college. Nevertheless, he had the curiosity requisite for stimulating his own development. Not only did he forge ahead without the companionship of kindred scientists, but he also worked under the handicap of a lack of sufficient apparatus. For instance, he had to make his meteorological observations without the services of either a thermometer or a barometer, because neither of these instruments was available (43).

ROBIE's mind was chiefly analytical; he displayed no propensity toward being an individual theorist. He was capable of judging the theoretical work of others, however, and his acceptance of

(41) Royal Society, *The Record of the Royal Society of London* (3rd. ed., London : Printed for the Royal Society at the Oxford University Press, 1912), p. 331.

(42) *New-England Weekly Journal*, Sept. 1, 1729, p. 3.

(43) DERHAM, " An Abstract of the Meteorological Diaries " pp. 266-67.

NEWTON's ideas is evidence of his openmindedness in this direction. Other examples of the refreshing scientific attitude which he evolved almost independently of his fellows are the stand which he took in the inoculation episode and his active opposition to superstition. In his pamphlet on the so-called meteor, he made this opposition very clear when he said " ... I don't mean that this Sight was not surprizing to me, for I have said it was before, but I only mean that no Man should fright himself by supposing that dreadful things will follow..." (44).

ROBIE made no important contributions to knowledge, nor did he train any important scientists. It is probable, however, that he had a considerable influence on the career of ISAAC GREENWOOD, who graduated in 1721 from Harvard where he later became the first Hollis Professor of Mathematics and Natural Philosophy. From ROBIE's letter to JURIN (45), it is positive that he was corresponding with GREENWOOD while the latter was obtaining an advanced scientific training in London, but it would be unwarranted to do much more than to place ROBIE in the stream of early science in the Colonies. ROBIE's importance lies in the fact that he added to the prestige of science, and kept it going in a society that had been forced into a strictly utilitarian way of living. He advanced scientific activity in New England, and cut down the weeds of superstition. The real significance of ROBIE as a scientist lay not only in his individual achievements but also in his position in that Harvard stream of science which flowed through THOMAS BRATTLE, THOMAS ROBIE and ISAAC GREENWOOD, and which burst forth under the aegis of Professor JOHN WINTHROP.

Cambridge, Massachusetts. FREDERICK G. KILGOUR.

(44) *Op. cit.*, p 8.
(45) Supra.

Buffon et les premières bêtes du Jardin du Roi : Histoire ou Légende ? (1)

Les historiens du Muséum d'histoire naturelle de Paris nous assurent qu'à l'exception de quelques oiseaux aquatiques, il n'y eut pas d'animaux au Jardin des Plantes avant la fondation de la ménagerie sous la Révolution (2). On croit souvent le contraire. Il existe une légende — qui se laisse parfois imprimer — d'après laquelle ce serait BUFFON qui aurait mis les premières bêtes au Jardin du Roi, dont il fut l'intendant de 1739 jusqu'à sa mort en 1788. Cette légende est assez ancienne. VICTOR HUGO, par exemple, y croyait, et certains vers de l'*Art d'être grand-père* ont sûrement beaucoup fait pour la propager :

> " Le comte de Buffon fut bonhomme, il créa
> Ce Jardin imité d'Evandre et de Rhéa
> Et plein d'ours plus savants que ceux de la Sorbonne,
> Afin que Jeanne y puisse aller avec sa bonne..." (3)

En questions de fait on croit plus volontiers les érudits que les poètes. Mais voici qu'un historien ne semble pas distinguer nettement entre la vérité historique et la légende : il a paru récemment un livre intitulé *Un Collaborateur de Buffon, l'Abbé Bexon* (4). L'auteur, M. BREMOND D'ARS-MIGRÉ, ne doit pas détester la poésie, puisque son ouvrage est plein d'enthousiasme

(1) Avant la Révolution le Muséum d'histoire naturelle, ou le " Jardin des Plantes," s'appela le Jardin du Roi.

(2) Cf. les deux livres du docteur E.-T. HAMY : " Les anciennes Ménageries royales et la Ménagerie nationale fondée le 14 brumaire," dans les *Nouvelles Archives du Muséum*, 3e série, V (1893), p. 9, et *Les derniers jours du Jardin du Roi et la fondation du Muséum d'histoire naturelle*, Paris, Impr. nat., 1893. Voir aussi : DENISE, L., *Bibliographie du Jardin des Plantes*, Paris, DARAGON, 1903, pp. 92-93.

(3) *Œuvres complètes de Victor-Hugo* (éd. HETZEL-QUANTIN), Poésie, t. XII, p. 61.

(4) Paris, Champion, 1936. Il s'agit de GABRIEL-LÉOPOLD-CHARLES-AMÉ BEXON (1747-1784).

et de lyrisme; mais en racontant la vie du jeune GABRIEL BEXON et puis les rapports du brave abbé avec l'Intendant du Jardin du Roi, il a très certainement voulu faire œuvre vraie. Or, en parlant de BUFFON, il lui arrive de nous faire assister à une promenade que le grand naturaliste fait dans le Jardin du Roi en compagnie d'ANTOINE et de BERNARD DE JUSSIEU (5) :

" Imaginons, d'abord, les trois amis se promenant à travers les allées et les bâtiments du Jardin du Roi, s'attardant à la Bibliothèque, parcourant les serres embaumées, frôlant les enclos derrière lesquels s'ébattent, crient, sifflent, chantent, beuglent, braient, hennissent, glapissent, vagissent, rugissent ou barètent les bêtes étranges que l'on commence d'amener, captives, à Paris, de tous les coins de l'univers..." (6)

M. BREMOND D'ARS-MIGRÉ a donc l'honneur de donner dans la même erreur que VICTOR HUGO. Il enchérit même sur la faute du poète : ANTOINE et BERNARD DE JUSSIEU sont morts avant l'agrandissement du Jardin, c'est-à-dire avant que BUFFON, faute d'espace sans doute, ait songé sérieusement à la création d'une ménagerie (7). Les animaux dont parle ici le biographe de l'Abbé BEXON viennent trop tôt. ANTOINE et BERNARD DE JUSSIEU ne les ont certainement jamais entendus au Jardin du Roi. Mais d'une façon plus générale, le souvenir de bêtes qui crient au Jardin avant 1794, est-il entièrement inexact ? Les historiens diront que oui, et ils auront probablement raison. Il y a pourtant dans le passage que je viens de citer un mot qui mérite qu'ils s'y arrêtent un instant : c'est le verbe ***barètent***. Il doit leur rappeler une lettre amusante et curieuse qui fait partie des archives du Muséum et qui est, je crois, inédite et inexpliquée. La voici avec quelques éclaircissements nécessaires :

On sait que BUFFON passait une grande partie de son temps à Montbard, en Bourgogne. Il pouvait s'absenter ainsi de la capitale grâce au dévouement de quelques hommes à qui il confiait en toute sécurité ses affaires à Paris. C'est ANDRÉ THOUIN (8),

(5) Célèbres botanistes français : ANTOINE (1686-1758), BERNARD (1699-1777).

(6) P. 61.

(7) Nous savons que BUFFON y a songé. Cf. BACHAUMONT, *Mémoires secrets*, à la date du 23 juillet 1782; BERNARDIN DE SAINT-PIERRE, *Mémoire sur la nécessité de joindre une ménagerie au Jardin National des Plantes de Paris*, Paris, 1792, pp. 4-5; et LOISEL, GUSTAVE, *Histoire des ménageries de l'antiquité à nos jours* (Paris, 1912, 3 vol.), t. II, pp. 316-317.

(8) 1747-1824. THOUIN devint jardinier en chef du Jardin du Roi sous l'administration de BUFFON.

par exemple, qui l'a représenté dans les travaux importants de l'agrandissement du Jardin (9). THOUIN écrivait souvent à son chef pour lui envoyer des rapports et des comptes. Un grand nombre de ses manuscrits et de ses brouillons de lettres ont été conservés au Muséum. En voici un passage qui nous intéresse ici :

" Les ouvriers paveurs, maçons et charpentiers sont occupés à réparer l'écurie des Cabinets et dans peu elle sera en état de recevoir les chevaux de M. votre fils (10); nous allons en retirer l'éléphant pour le placer dans le Pavillon Goulas, toute réflexion faite, M. DAUBENTON (11) trouve qu'il sera mieux là." (12)

Ce brouillon porte, comme millésime, la date du 10 mars 1783. Quelques années plus tard, le 5 juin 1786, THOUIN raconte à son chef l'incident suivant :

" Il y a eu dimanche huit jours qu'un homme assez bien couvert [habillé] soupçonnant que sa jeune et jolie épouse l'initiait à son insu dans la Grande Confrérie, l'épia et la trouva au Jardin du Roi avec son galant. Malgré la décence due au lieu, malgré que ce fût en plein jour et au milieu du Jardin, il la soufleta rudement. Le galant voulut l'empêcher et la querelle allait devenir tragique lorsque le deuxième garde-bosquet est arrivé. Il arrêta les délinquants et les conduisit à M. GUILLOTTE (13), qui mit en prison jusqu'à la fin du jour dans la loge de l'éléphant l'incivil époux, après quoi il le renvoya. Pendant que cet homme était séquestré, le public s'amassait aux fenêtres et l'on pourrait dire que l'éléphant, tout extraordinaire qu'il doit être pour les habitants de Paris, le parut moins que cet époux bourru si peu au courant des usages de son pays." (14)

Donc, si du vivant de BUFFON le Jardin du Roi n'était pas « plein d'ours plus savants que ceux de la Sorbonne, » on y put voir bel et bien, à un moment donné, un éléphant. Qu'est-ce qu'il est devenu ? Nous n'en savons rien; il semble avoir disparu sans laisser de traces. Était-ce une pièce empaillée ? C'est possible. En 1782 un éléphant était mort à la ménagerie de Versailles.

(9) Cf. les lettres de BUFFON à THOUIN dans la *Correspondance générale de Buffon* (volumes XIII et XIV de l'édition des œuvres complètes publiée par J.-L. DE LANESSAN), Paris, A. LE VASSEUR, 1884-1885.

(10) GEORGES-LOUIS-MARIE LECLERC, comte de BUFFON (1764-1793).

(11) LOUIS-JEAN MARIE DAUBENTON (1716-1799), ami et collaborateur de BUFFON.

(12) Muséum d'histoire naturelle, MS. 882, pièce 3.

(13) Chef des gardes du Jardin.

(14) *Ibid.*, pièce 4. BUFFON a reçu cette lettre. Le 10 juin 1786 il écrit à THOUIN : " J'aime beaucoup aussi l'histoire du mari bourru, par la gaieté avec laquelle vous me la racontez." Cf. *Correspondance générale de Buffon*, t. XIV, p. 323.

Son cadavre fut disséqué au Jardin du Roi (15). Si l'on a conservé la peau de la bête, il se peut que ce soit cette pièce dont parle THOUIN dans ses lettres à BUFFON. Mais alors pourquoi l'avoir mise à l'écurie et non dans le Cabinet destiné à recevoir d'aussi précieux objets? Il semble bien d'ailleurs être question, dans ces deux passages, d'un animal vivant. Ne faudrait-il pas, en effet, voir dans cet éléphant un précurseur de ce « Hans » et de cette « Parkie » qui, confisqués en 1794 par les armées républicaines dans les Pays-Bas, eurent ensuite à Paris un succès auquel seule la girafe de 1827 atteignit (16)?

University of Maryland. WILLIAM F. FALLS.

(15) Cf. LOISEL, *op. cit.*, t. II, p. 150.

(16) Sur ces deux éléphants, leur vie, leurs amours, leurs mœurs, etc., voir DENISE, *op. cit.*, nos. 451-454, 456, 469, 475; et LOISEL, *op. cit.*, t. II, pp. 41-49.

Lunar influences on living things

In the course of a journey from Boston to Demerara in the good Canadian ship Lady Drake, we landed on December 15, 1936 in St. Vincent, one of the Windward Islands. We visited Fort Charlotte upon Berkshire Hill, one of the many fortified places established during the eighteenth century in the West Indies when the peace of those heavenly islands was frequently troubled by wars. Some of the old military buildings are now used as hospices for the poor of the colony, one of them being devoted to the insane. The guard who took me around told me that the insane, male and female, were generally easy to handle, except about the time of full Moon when special precautions had to be taken in order to restrain them.

I knew of that kind of superstition before, and indeed it is difficult not to know of it for it is crystallized in our words " lunacy, lunatics," yet was much impressed when I was thus suddenly confronted with it. It is one thing to read about a curious belief in a book; it is quite another to face it in its stark reality, and especially when it has been as it were sanctioned by the routine of a medical institution. Of course it was easy enough to realize how this had come to pass. Given the initial fear that mental patients might be excited by the full Moon, as soon as adequate precautions were taken they tended to create the very conditions justifying them. The physicians and nurses were apprehensive of incipient trouble as the Moon was waxing to its fullness, and they locked up their patients or restrained them in various ways; these patients were naturally becoming more excited. Consciously or unconsciously they played up to the general expectations and thus each full Moon helped to confirm the original belief. (1)

(1) " Up to the year 1808, according to the English physician, JOHN HASLAM, lunatics (who were still supposed to be under lunar influence) were bound, chained and even flogged at particular phases of the Moon, to prevent the accession of

During the remainder of that very delightful voyage I often thought of the St. Vincent lunatics, the first consistent lunatics I had ever seen, and—being a historian of science—I tried to reconstruct the genesis of that curious situation. After my return, I made a few investigations the results of which are given below.

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To begin with let us remember that there is nothing absurd or self-contradictory in the idea that the Moon might influence the minds of men. Such an influence is conceivable, but it has not yet been proved, nor is it probable in the light of present knowledge. Indeed a tangible influence is highly improbable. We call the assumption of such an influence a " superstition," because it is unproved and unlikely. The superstition lies not in the concept but in taking it for granted without warrant.

Lunar influences upon life and mind imply neither contradiction nor absurdity *per se;* they may be real or not; that is an experimental problem. Or they may be real enough yet intangible; or if intangible and immeasurable to-day, they may become tangible and measurable to-morrow or later. However, there is no hope of a secular influence; whatever influence there be would depend on the phases of the Moon, that is on a very short cycle. There is thus no opportunity for an accumulation of sufficient length to permit infinitesimal influences to become tangible.

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violence. BENJAMIN RUSH himself subscribed to the belief in lunar influence on the insane, with qualifications. Characteristically, he once set the attendants at the Pennsylvania Hospital to observe the behavior of patients through the night under various phases of the moon, in order to test its influence. From the reports he received he thought it possible to give a scientific explanation of the lunar hypothesis. ' There are few cases in which mad people feel the influence of the Moon,' he concluded, ' and when they do, it is derived chiefly from an increase in its light.' He added, however, that ' the absence of its light may be attended with equal commotions ' in patients afflicted with ' tristimantia ' (a term RUSH substituted for melancholia)." ALBERT DEUTSCH : *The mentally ill in America. A history of their care and treatment from colonial times* (p. 82, New York 1937; *Isis* 29, 197-200). In a footnote DEUTSCH refers to GERALD OF WALES (XII-2), but the superstition is much older.

J. SADGER : Sleep walking and moon walking. *(Nervous and mental disease monograph series* n° 31, 150 p., New York 1920). WILLIAM HARRIS STAHL: Moon madness (*Annals of medical history*, vol. 9, 248-63, 1937).

In order to illustrate the danger of a priori rejection of such a concept, let us bear in mind GALILEO's mistake with regard to the tides. The influence of the Moon (and of the Sun) upon the tides had been noticed by some Greeks as early as the second half of the fourth century B. C. (2) and a luni-solar theory of the tides, with the addition now and then of various astrological excrescences had become a common-place of the Middle Ages. GALILEO being anxious to avoid " astrological " superstitions, flatly rejected the possibility of lunar influences upon the tides. He developed a new theory based on the rotation of the Earth, which theory would thus help to confirm the Copernican system, and he derided KEPLER's " occultism " on the subject. (3)

This Galileian episode is extremely interesting. Here was one of the best intellects of all ages, but for once his passion for rationalism had led him astray, even as innumerable men had been deceived by their irrational love of mystery. Rationalism had led him to " prejudice " which is hardly better than " superstition."

In extenuation of his rashness we should add, first, that the mediaeval luni-solar theory of the tides had an unfortunate astrological and irrational appearance, and second, that no good explanation of the tides was possible before the discovery of universal gravitation. NEWTON's *Principia* (1686) which contained that discovery contained also the first valid explanation of the tides, again a luni-solar theory but very different from the old one. NEWTON's explanation made quantitative verifications possible and its posterior development constitutes one of the most impressive chapters of celestial mechanics. Yet for all that the explanation which is given, satisfactory as it is in many respects, is

(2) PYTHEAS of Massilia and DICAEARCHOS of Messina, IV (2) B.C., p. 144-45; SELEUCOS the Babylonian, II(1) B.C., p. 183; POSIDONIOS of Apamea, I(1)B.C., p. 204; etc. (The page numbers refer to vol. 1 of my *Introduction*).

(3) See GALILEO's *Discorso del flusso e reflusso del mare* written by him in 1616 (but not printed until 1780) and his *Dialogo... sopra i due massimi sistemi del mondo* (Florence 1632). The fourth day is devoted to the discussion of the tides. Here is what he says of KEPLER (vol. 7, p. 486 of FAVARO's *Opere*) " Ma tra tutti gli uomini grandi che sopra tal mirabile effetto di natura hanno filosofato, più mi meraviglio del KEPLERO che di altri, il quale, d'ingegno libero ed acuto, e che aveva in mano i moti attribuiti alla Terra, abbia poi dato orecchio ed assenso a predominii della Luna sopra l'acqua ed a proprietà occulte, e simile fanciullezze."

merely formal. Universal gravitation savors a little of occultism. How could we really conceive a pull transmitted immediately anywhere to any distance? We can express that idea, translate it into mathematical language, and write equations, which in their turn may be transformed and subjected to endless verifications; hence we can prove that the hypothesis is correct but we cannot understand it. The same remark would apply even more strongly to the gravitational conceptions implied in the general theory of relativity. (4)

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In any case the tides are accounted for by the influence of the Moon and subsidiarily of the Sun, not simply *in toto* but in considerable detail. On that basis one could already claim that the influence of the Moon upon living things is proved, for the Moon causes the tides, and the tides influence living things including men in many ways. However in what follows, we shall consider the tidal influence as granted, and investigate only other possibilities.

Before leaving the subject of tides a few words must be said about the atmospheric tides. The first to discuss them was, I believe, D'ALEMBERT in his Reflexions on the general cause of winds, a memoir crowned by the academy of Berlin in 1746. (5) LAMARCK, who was all his life deeply interested in meteorology, touched the subject in 1798. (6) It had been investigated experimentally by LAPLACE in Brest 1774, and a mathematical theory was published by him in the *Mémoires de l'Académie des sciences* for 1775. He came back to the subject in his *Mécanique céleste* (vol. 5, 149-167, 237-83, Paris 1825); unfortunately his analysis was based upon very insufficient data and hence doomed to failure. The reality of atmospheric tides was first established in 1842

(4) A very clear survey of the difficulties involved was made recently by PAUL HEYL : What is gravitation? (*Scientific monthly*, August 1938, p. 114-23).

(5) Published by him in Latin, *Meditationes de generali ventorum causa*, with French translation (Paris 1747).

(6) De l'influence de la Lune sur l'atmosphère terrestre (*Journal de physique*, vol. 46, 428-35, 1798). Soon translated into English. MARCEL LANDRIEU : LAMARCK (134, 453, Paris 1909).

by Sir JOHN HENRY LEFROY (1817-90) for St. Helena, and in 1852 by CHARLES MORGAN ELLIOT (1815-51) for Singapore; valuable observations were accumulated by Dutch astronomers at the observatory of Batavia.

These indications are not meant to be exhaustive but exemplary. Atmospheric tides do exist, but the variations in barometric pressure which they cause are very small and very difficult to dissociate from changes due to other causes, e.g., variations in temperature. It is not by accident that those tides were first evidenced in tropical countries, where their amplitude was larger and where they were less completely obscured by other barometric variations. If those tides influence living things, such influence can hardly be tangible, even in the tropics. (7)

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Changes in atmospheric pressure are only one element of the weather among many others. As to the influence of the Moon upon the weather in general, the common people of all countries are unanimous. If the argument of consensus were as acceptable in science as it is in theology, the control of the weather by the Moon could hardly be denied. Indeed the farmer's almanacs of all countries take it for granted. No belief is more widespread or more circumstantial than that one, and yet it has never been substantiated by scientific investigations. It is not the case that

(7) There is an abundant literature on this intricate subject. See for ex., SYDNEY CHAPMAN : The semidiurnal oscillation of the atmosphere (*Quarterly journal of the Royal meteorological society*, vol. 50, 165-95, 1924); The lunar tide in the Earth's atmosphère (*Proceedings, Royal Society*, vol. 151, 105-117, 1935). C. L. PEKERIS : Atmospheric oscillations (*Proceedings, Royal Society*, vol. 158, 650-71, 1937). PEKERIS' paper was kindly brought to my attention by my Harvard colleague, Professor CHARLES F. BROOKS. E. V. APPLETON and K. WEEKES : Tides in the upper atmosphere (*Nature*, vol. 142, 71, July 9, 1938), apropos of the investigation of upper atmospheric oscillations by means of radio waves; the tide at 110 km. is almost 6000 times that at ground level, the phase being the same.

It has been suggested that tidal forces might cause volcanic explosions by a kind of trigger action. Sir GERALD LENOX-CONYNGHAM : Montserrat and the West Indian volcanoes (*Nature* 139, 907-10, 1937). On the influence of the Moon on earthquakes see HARLAN TRUE STETSON : Correlation of frequencies of seismic disturbances with the hour angle of the Moon (*Publications du Bureau central séismologique international*, A, fasc. 15, 16 p., 1937).

scientists have refused to investigate it; on the contrary, many distinguished astronomers have done so, for example, OLBERS in 1818 and MÄDLER in 1837. (8) The conclusions of the latter may be quoted for the sake of curiosity.

"1. Der Mond ist nicht ohne allen Einfluss auf die klimatischen Verhältnisse des Erdkörpers, allein dieser Einfluss erscheint überall nur als ein geringer und untergeordneter in Vergleichung sowohl zu dem der Sonne, als auch zu den übrigen von noch unerforschten Ursachen herrührenden Veränderungen der Witterung.

"2. Dieser Einfluss manifestirt sich in den Veränderungen des athmosphärischen Druckes (des Barometers) so dass zu gewissen Phasenzeiten das Barometer constant höher steht als in andern, so wie zur Zeit der Erdferne des Mondes höher als während seiner Erdnähe.

"3. Er zeigt sich ferner in den Veränderungen der Luftwärme, dergestalt dass während der Erdferne des Mondes das Thermometer im Mittel höher steht als zur Zeit der Erdnähe, wie denn auch die Phasen des Mondes einen Einfluss auf die Luftwärme äussern.

"4. Endlich erkennt man den Einfluss der erwähnten Punkte der Mondsbahn auch in der ungleichen Vertheilung des Regens, so wie der Heiterkeit der Athmosphäre.

"5. Ein Einfluss der Declination des Mondes lässt sich in der Art nachweisen, dass Jahrgänge, in denen der Mond die Maxima seiner nördlichen und südlichen Declination erreicht, im Durchschnitt eine günstigere und namentlich dem Weinbau vortheilhaftere Witterung haben, als solche, wo er sich weniger vom Aequator entfernt.

"6. Die allgemeinen Gesetze der Schwere sind unzureichend, diese Einwirkungen sowohl qualitativ als quantitativ zu erklären, und eben so wenig reichen die uns theoretisch bekannten Eigenschaften des Mondlichts zur Darstellung dieser Veränderungen aus; demnach scheint nur die Annahme übrig zu bleiben, dass es eine dritte uns noch unbekannte Art gebe, wie Weltkörper auf einander wirken.

"7. Die bisherigen Untersuchungen reichen noch nicht hin, numerisch bestimmte Formeln und Gesetze für diese Einwirkungen festzustellen, und es ist deshalb nöthig noch eine lange Zeit hindurch genaue Beobachtungen fortzusetzen und zu berechnen."

The conclusions of present day astronomers and meteorologists would be even more conservative. The universal Moon folklore is "superstition," not science. (9)

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(8) WILHELM OLBERS : Über den Einfluss des Mondes auf die Witterung (*Z. für Astronomie und verwandte Wissenschaften*, vol. 5, 234-44, Tübingen 1818). WILHELM BEER and JOHANN HEINRICH MÄDLER : Der Mond nach seinen kosmischen und individuellen Verhältnissen, oder Allgemeine vergleichende Selenographie (quarto XX+412 p., Berlin, 1837). Anhang IV. J. H. MÄDLER : Über den Einfluss des Mondes auf die Witterung (p. 154-68).

(9) For a review of moon folklore, see the posthumous book of P. SAINTYVES

Does this mean that all the facts adduced by farmers, concerning the influence of the Moon upon the weather, their crops and livestocks, are wrong? Not necessarily; they are unproved and most of them, unlikely. That is all. The true scientist should remain open minded. Lunar influences which are not detectable by means of physical instruments might conceivably be detected by living creatures.

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What about menstruation? The length of its cycle is astonishingly close to that of the lunar cycle. CHARLES DARWIN pondered on that and suggested that the menstrual period might be a vestige of a time when our distant ancestors were more immediately submitted to tidal influences (*Descent of man*, end of chapter 6, 1871). The first scientific investigation I know of was made by SVANTE ARRHENIUS (1898), who concluded that there was a correlation between menstruation and atmospheric electricity, itself related to the lunar tropical cycle. ARRHENIUS' conclusions have been recently gainsaid (1937). (10)

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As to the possible correlation between atmospheric elasticity and terrestrial magnetism and the Moon, I applied to my Carnegie Institution colleague, Dr. JOHN ADAM FLEMING, director of the Department of terrestrial magnetism, who kindly sent me the following answers, allowing me to reproduce them here for the convenience of the *Isis* readers.

Washington, D. C., May 17, 1937.

... There appears to be no connection between the phenomena of atmospheric electricity and the Moon. A relationship between terrestrial magnetism and the Moon has been very definitely established.

(i.e., ÉMILE NOURRY, 1870-1935) : *L'astrologie populaire étudiée spécialement dans les doctrines et les traditions relatives à l'influence de la lune* (464 p., Paris 1937; *Isis* 30, 387).

(10) SVANTE ARRHENIUS : Die Einwirkung kosmischer Einflüsse auf physiologische Verhältnisse (*Skandinavisches Archiv für Physiologie*, vol. 8, 367-416, 1898). DONALD L. GUNN, PENELOPE M. JENKIN, ALISTAIR L. GUNN : Lunar periodicity in Homo sapiens L. (*Nature*, vol. 139, 841, 1937).

Owing to tidal motions of the Earth's atmosphere across the lines of force of the Earth's permanent magnetic field electric currents are produced which give rise to a diurnal variation in the Earth's magnetism. There is a diurnal variation which agrees in period with the solar day and another which agrees in period with the lunar day. Both of these are explained on the same basis, since there is an atmospheric lunar tide and an atmospheric solar tide. The solar diurnal-variation in magnetism is about 15 times as great as the lunar variation; this is also the ratio between the solar and lunar atmospheric tides. It is striking to note in this connection that the lunar variation in terrestrial magnetism changes about 30 per cent from lunar apogee to lunar perigee, which is approximately the amount of variation in the tide-raising forces of the Moon. The solar atmospheric tide is greater than the lunar atmospheric tide because it is assisted by thermal effects coupled with resonance phenomena of the atmosphere.

In the earlier days of terrestrial magnetism—and this may interest you particularly because of its historical significance—the Moon was believed to exert another influence on terrestrial magnetism. This false relationship was first pointed out by J. A. BROUN, *Transactions Royal Society of Edinburgh*, v. 22, p. 511 (1861). It consists of a quasi-periodic change in the intensity of the Earth's magnetic field at intervals of a lunar month. More recent investigations have shown that this effect is due to the Sun, the rotation period of which is nearly the same as that of the revolution of the Moon about the Earth. This rotation period of the Sun appears to cause recurrences of magnetic storms at about 27-day intervals, associated with which are auroral displays.

Since all ephemeral changes in the Earth's magnetism are associated with the induction of electric currents in the earth, these phenomena must all be associated with variations in earth-currents. The solar diurnal-variation in earth-currents has been clearly established. As far as we know, no article has appeared showing the lunar diurnal-variation in earth-currents, but an article has just been received for publication in the *Journal of terrestrial magnetism* by J. EGEDAL purporting to show a lunar diurnal-variation in the earth-currents at Tucson, Arizona. Mr. ROONEY of our department is at present engaged on investigation of the lunar diurnal-variation in earth-currents at Tucson and hopes to have definite results on this in the near future...

May 28, 1937.

... You mention in your letter that lunar or astral influences on life are probably transmitted by electrical or magnetic channels. To a physicist such a view does not seem tenable. No electrical effect of the Moon has ever been detected and the magnetic effects are so slight that it does not seem likely that living things could be sensitive to them, since the substance of all animals and plants is highly non-magnetic. The nightly closing of some flowers does not seem attributable to electrical differences because most flowers are so located as to be shielded from variations in the Earth's electrical field, and because much larger fluctuations in the Earth's electrical field take place within a day and from day to day than occur from day to night...

June 3, 1937.

... We do not know if we have succeeded in making clear the exact part which the Moon plays in the electrical and magnetic effects on the Earth. According to the best beliefs of scientists in the field, the Moon does indirectly give rise to

electric currents flowing at great altitudes in the atmosphere, that is, above 80 km or so. These currents are perceived only through their magnetic effects and those magnetic effects are discernible only by extensive statistical analysis. These effects are so slight that irregular fluctuations completely overwhelm them in a short series of data. This method of statistical analysis is one of the triumphs of modern scientific research...

***

To return to living things, a far better case than menstruation is afforded by the habits of various sea animals. This had been observed a long time ago. Thus ARISTOTLE remarked apropos of sea-urchins (*De partibus animalium*, book IV, 5, BEKKER 680^{a}; my quotation is taken from the Oxford translation) :

" Though the ova are to be found in these animals even directly they are born, yet they acquire a greater size than usual at the time of the full Moon; not, as some think, because sea-urchins eat more at that season, but because the nights are then warmer owing to the moonlight."

It is probable that the fact reported by ARISTOTLE was a part of the fishermen folklore, and had been so for an incalculable time, but he rationalized it. It is unnecessary to give later references to classical literature, but in order to illustrate the universality of that kind of belief, I shall point out its occurrence in the encyclopaedic treatise which was compiled under the direction, or by order, of LÜ PU-WEI (d. 235 B. C.). (11)

After ARISTOTLE and LÜ PU-WEI these ideas continued to be entertained not only by fishermen, but by scholars and scientists, and they crop up time after time in the learned treatises of many nations. To make a big jump, let us quote from the *Philosophical transactions* of March 11, 1666 (1667). Among the " inquiries for Suratte and other parts of the East Indies," we find the following (p. 419) :

30. Whether those *Shell-fishes*, that are in *these parts* plump and in season at the *Full Moon*, and lean and out of season at the *New*, are found to have contrary *Constitutions* in the *East-Indies*?

These beliefs have not been established by scientific investi-

(11) According to HERBERT A. GILES : *Chinese biographical dictionary* (558-60, London 1898), that book is a later compilation, dating probably from the Eastern Han dynasty, that is, from the first two centuries of our era.

gations, but other facts of the same kind, and in appearance equally fantastic, have been duly substantiated. As I am walking here entirely outside of my own field, it will be safer not to attempt a description of those " marvelous " facts in my own words, but to quote them from an excellent manual recently published. (12)

" There are at any rate in tropical, as well as temperate, waters animals which, if not giving an index of the season of the year, show without fail, by their spawning habits, the times of the lunar months. It is quite a common occurrence to find that marine animals will breed at certain fixed stages of the Moon. It has been shown that our common oyster has a tendency to " spat " in much greater numbers during the week following the full and new Moon than at any other time. In Egyptian waters also there is a sea-urchin that breeds during the nights when the Moon is full. But perhaps one of the most surprising cases of this kind is supplied by a small marine worm from the tropical seas near Samoa in the Pacific Ocean, the " Palolo worm " (*Eunice viridis*). This worm can be regarded as a veritable sea calendar. All the year round it lives in holes and crevices among rocks and coral growth on the sea bottom. But true to the very day, each year the worms come to the surface of the sea in vast swarms for their wedding dance. This occurs at dawn just for two days in each of the months, October and November, the day before, and the day on which the Moon is in its last quater; the worms are most numerous on the second day, when the surface of the ocean appears covered with them. Actually it is not the whole worm that joins in the spawning swarm. The hinder portion of the worm becomes specially modified to carry the sexual products. On the morning of the great day each worm creeps backwards out of its burrow, and when the modified half is fully protruded it breaks off and wriggles to the surface, while the head end of the worm shrinks back into its hole. The worms are several inches in length, the males being light brown and ochre in colour and the females greyish indigo and green. At the time of spawning the sea becomes discoloured all around by the countless floating eggs...

... " There is also a closely allied form, the Atlantic Palolo *(Eunice fucata)*, whose habits are very similar. The swarms of this worm have been studied for nine years at Tortugas and they always appeared within three days of the time of the Moon's last quarter between June 29th and July 28th. The sexual portions begin to rise to the surface at least two hours before sunrise; by sunrise they are present in countless numbers and when the first rays of the sun strike the water they break up and discharge the eggs. The dying bodies sink to the bottom where they are eagerly devoured by waiting fish and by three hours after sunrise none are to be seen.

" At Amboina in the Malay Archipelago there is a similar worm, the ' Wawo,' which swarms on the second and third nights after the full Moon of March and April.

" The Japanese can also boast a Palolo; they call it " Bachi " *(Ceratocephale osawai)*. In this case it is the front end of the worm which becomes modified and breaks off. The swarming occurs during the nights immediately after new

(12) F. S. RUSSELL and C. M. YONGE : *The seas*. Our knowledge of life in the sea and how it is gained (London, FREDERICK WARNE, 1928; revised edition 1936; *Isis* 28, 269). I quote from the revised edition (p. 250-53, 1936).

and full Moon in October and November and the fishermen catch them by means of lights to which the worms are attracted; they use them then as bait.

"It is hard to understand what can be the cause of these curious phenomena. It has been thought that the stimulus for spawning might be found in the state of the tides. Experiments have shown however, that probably the tide can have no influence, for worms placed in floating tanks spawn naturally at the usual times, and in this case the worms could have had no means of telling the state of tide either by the pressure of the water or the speed of its movement.

The case of the Egyptian sea-urchin briefly referred to above is so remarkable that I should like to add the following information, derived from the very remarkable study by H. MUNRO FOX : Lunar periodicity in reproduction (*Proceedings of the Royal Society*, B, vol. 95, 523-50, 1924). He concludes :

"1. A belief in a variation in the bulk of marine invertebrates which serve as articles of food, correlated with the lunar period, was general in ancient Greece and Rome and persists to-day, in countries bordering the Mediterranean and at Suez. It is shown in this paper that, while the belief is based on fact as concerns sea-urchins in the Red Sea, it is false regarding sea-urchins in the Mediterranean and other invertebrates in both seas. It is suggested that in ancient Egypt the belief spread from Suez, passed to Greece, and has persisted in Mediterranean countries until to-day.

"2. The details of the lunar reproductive cycle of the echinoid *Centrechinus (Diadema) setosus* at Suez are described. At each full Moon during the breeding season spawning takes place. After this a fresh crop of genital products is developed, to be spawned at the ensuing full Moon. One and the same individual may become sexually mature at consecutive lunar periods.

"3. There is no lunar reproductive periodicity in the echinoid *Strongylocentrotus lividus* at Alexandria, Naples or Marseilles; nor in the mussels *Mytilus sp.* at Alexandria and *Mytilus variabilis* at Suez. These forms, however, show evidence of simultaneous though non-periodic spawning.

"4. There is no lunar periodicity in the rate of growth of fruits.

"5. The possibility of lunar photosynthesis is tested."

Dr. Fox has popularized the results of his investigations in a delightful little book, *Selene or Sex and the Moon* (London 1928.)

* * *

And finally let us come back to the facts which started our reflections,—the influence of the Moon on the mind of man. Such influence is entirely unproved. Nevertheless not only insane people, but poets and lovers have been frequently moon-struck. If they believed honestly and strongly enough that they were influenced by the Moon, it cannot be denied that they were

actually influenced to some extent, but we thus venture into a purely subjective field which it is well nigh impossible to explore.

To the moonstruck poets and romanticists should be added at least one scientist, who happens to be one of the greatest of the last century, the Swedish chemist BERZELIUS, one of the founders of modern chemistry. According to his autobiography published in 1901 for the Swedish Academy of Sciences by H. G. SÖDERBAUM and recently Englished by OLOF LARSELL (Baltimore 1934; *Isis* 24, 149-51), BERZELIUS was tormented by a periodic migraine which he believed to be induced by the Moon. Thus he states (p. 96 of English translation) :

" Since my twenty-third year I had been tormented by a periodic headache, commonly called migraine. At first this occurred at long intervals but soon showed itself two times per month, falling with the greatest regularity on the day when the new Moon or the full Moon occurred, and lasting from 8 A.M. to 8 P.M."

Adding in a footnote (p. 97) :

" This singular regularity, the connection of which with the position of the Moon I was not aware of at first, continued for 14 years. During my visit in Paris in the winter of 1818-19 I happened to tell of it to LAPLACE, who doubted my account, and added that OLBERS, who was as great an astronomer as physician, had recently demonstrated in a paper that no noticeable influence was exercised by the Moon in diseases. The next time I was seized with the migraine and had prepared myself to remain at complete rest in a dark room, I was disagreeably disturbed by an invitation to dinner with LAPLACE, which naturally I could not accept. When we met several days afterward he reported that it had been a snare laid for me; that is to say, he desired, with the calendar in hand, to convince me that such a regularity did not exist, at a time when I myself certainly would not have such exact knowledge of the days of the changes of the Moon as at home. I answered him that in this he predicted correctly, but nevertheless, I was unfortunately not left in ignorance of when they occurred."

Other statements concerning his migraine will be found ibidem pp. 108, 110, 116, 117. For example, on p. 116 he remarks :

" The cure at Karlsbad had contributed more than I could have hoped to the betterment of my health. The periodic headaches returned but seldom during the following winter, although always then on one of the customary days of change of the Moon, but now were always less severe."

He admits that some time after 1823, thanks to the use of artificial Karlsbad waters, he was completely freed of his migraine,

but does not retract his opinion that it was originally caused by the Moon.

***

Scientists will judge BERZELIUS' aberration in many ways. Two types of reaction may be illustrated, which I shall name the reaction of conceit and that of humility. The first is but too common among scientists, especially the least educated (those whom the French call " les primaires "). The conceited scientist will not hesitate to condemn the illustrious Swede. " Why ", he would say, " your BERZELIUS, when he had a headache, was hardly wiser than an old woman. He ought to have known better." Other scientists, humbler in spirit and more tolerant, are less prone to condemn than to explain; they are intrigued by BERZELIUS' strange behaviour, but will give him at least the benefit of their doubts. They would answer to his impetuous accusers, " Wait a minute. BERZELIUS was not a fool. He knew the principles and the practice of scientific method. If he persisted in blaming the Moon for his migraine, perhaps we should investigate the subject more thoroughly."

In other words, instead of triumphing over BERZELIUS' " superstition," the humbler and I believe the wiser kind of scientist would take counsel from it, and not be too hasty in rejecting facts which do not yet fall within the orbit of his explanations. It may be, nay, it is highly probable, that moonstruckness in all its varieties is a purely subjective phenomenon; yet it is not impossible that there be deep in it a kernel of objectivity. It may be worthwhile to dig for that kernel. Experiments, such as are conducted by the zoologists and oceanographers, may yet throw more light on the Moon and life.

May 1937. GEORGE SARTON.
Revised July 1938.

Notes and Correspondence

Rectification d'un passage de la réponse à la Query 75.—Par le dernier cahier d'*Isis*, je viens d'apprendre (T. XXIX, 1938, p. 410) que j'aurais découvert un ms. de G. DE LUNIS. Comme je n'ai pas l'habitude de me revêtir de la peau du lion, je m'empresse de déclarer que mon intervention dans la question se borna à fournir à M. ENESTRÖM (d'après le désir qu'il m'avait exprimé) la photographie d'une page de ce ms. qui était connu bien avant ma naissance. Voyez en effet le T. IX (1908), III Série, p. 73, de la *Bibliotheca mathematica*.

GINO LORIA.

Réponse à la question 78.—**Sociétés dont le nom commémore des savants illustres** (*Isis* 29, 407-08). Monsieur MARC JARYC, du Bureau de documentation de la Fédération des sociétés françaises des sciences philosophiques, historiques, philologiques & juridiques, Siège : Sorbonne (Institut de psychologie), nous écrit le 21 novembre 1938 : " Vous trouverez les renseignements au sujet des questions soulevées par M. PELSENEER dans le ' Répertoire des périodiques philosophiques, historiques, philologiques et juridiques de langue française ' et dans le ' Répertoire des Sociétés françaises de sciences philosophiques, historiques, philologiques et juridiques ' que j'ai publiés avec M. PIERRE CARON, directeur des archives de France. Je me fais un plaisir de vous les envoyer par le même courrier sous pli séparé."

Le *Répertoire des sociétés françaises* etc. (1938) est un volume de 282 p. contenant des renseignements clairs et précis sur plus de 556 sociétés. Le *Répertoire des périodiques de langue française* (354 p., 1935) nous rend les mêmes services avec la même exactitude pour 1496 périodiques. Un supplément paru en 1937 augmente le nombre des périodiques jusqu'à 1686. Ces volumes sont fort bien indexés et d'une utilisation fort commode. Ils sont publiés par la Maison du livre français à Paris, et coûtent 50 fr. chacun, le supplément 15 fr. G.S.

Question no. 81. — **Eugène de Sicile** (*Introd.* 2, 346).

Je me propose d'entreprendre une édition critique, d'après l'ensemble des manuscrits connus à ce jour, de la traduction latine de l'arabe, par

l'émir EUGÈNE DE SICILE, de l'Optique de CLAUDE PTOLÉMÉE, étant donné que l'unique édition de cet ouvrage, publiée en 1885 par GILBERTO GOVI (Turin, PARAVIA), d'après le seul Codex Ambrosianus T. 100. sup., est aujourd'hui épuisée.

Avant d'aborder définitivement ce travail de longue haleine, je désirerais vivement m'assurer qu'il n'est pas déjà commencé par un autre philologue ou par un historien des sciences.

ALBERT LEJEUNE,
Licencié en philologie classique de l'Université de Louvain

Rue Tilkin, 4, Liége, Belgique.

Query no. 82. — John de Casali (fl. 1346-1375).

JOHN DE CASALI's query on the velocity of the motion of alteration dated 1346 in a Riccardian Ms. of Florence attracted LYNN THORNDIKE's attention in that Ms. and also in a Vatican Ms. (no. 3026). See his article " Vatican Latin MSS in the history of science and medicine " (*Isis* 13, 53-102, 1929, no. 50). According to THORNDIKE, the same text was printed in Venice 1505 in the book entitled " Questio de modalibus BASSANI POLITI. Tractatus proportionum introductorius ad calcutiones SUISSET. Tractatus proportionum THOME BARDVARDINI. Tractatus proportionum NICHOLAI OREN. Tractatus de latitudinibus formarum eiusdem NICHOLAI. Tractatus de latitudinibus formarum BLASII DE PARMA. Auctor sex inconvenientium " (73 f., Venice, SCOTUS, 1505). That book is not available to me, but I have copied the whole title (or table of contents) as given in the *Deutscher Gesamtkatalog* (vol. 12, 519, 1938), because it is interesting to know the contents of that collection of writings on proportions, forms, and latitudes, and if CASALI's treatise is included in it, the other treatises will help us to classify it grosso modo. The fact that CASALI's treatise is not mentioned in the title does not prove, of course, that it is not included in the collection. (It is included at fol. 57-70).

Says THORNDIKE : " JOHN DE CASALI was a doctor of theology and native of Montferrat. In 1375 GREGORY XI made him his nuncio to FREDERICK, king of Sicily."

I suppose he was a GIOVANNI (or GIOANNI) da Casale Monferrato in the province of Alexandria, Piedmont. I found no trace of him in VINCENZO DE CONTI : *Notizie storiche della Città di Casale del Monferrato* (11 vols. Casale 1838-42) nor in various other books on Piedmont. Who was he, and what was his contribution, if any, to the problems of forms and latitudes ?

There are copies of the Venetian edition of 1505 in the British Museum and the Bibliothèque nationale of Paris. See PIERRE DUHEM : *Études*

sur LÉONARD DE VINCI (vol. 3, 492, Paris, 1913); LYNN THORNDIKE and PEARL KIBRE : *A catalogue of incipits* (756, Utrum in mobilibus, New York, 1937). G. S.

Gregorius Reisch (German Carthusian, encyclopaedist, d. Freiburg 1523).—Your contribution on " Scientific incunabula " is very interesting and I am reading it with both pleasure and profit. I wonder if you would mind if I called attention to an error in it on p. 193 in which you state that the first edition of REISCH, *Margarita philosophica* appeared in 1496. Actually, the first edition (and so stated in its colophon) was printed in Freiburg in 1503. For an explanation of the origin of this error, see Klebs, *Incunabula*. p. 282 and Sabin, *Dictionary of books relating to America*, v. 16, p. 509-10.

In our opening exhibit of the Plimpton Library we showed the tower of knowledge from the *Margarita* and then " built " it with the contemporary books included in it. So we made some study of the editions of the book to get our data correct. You probably know of the two bibliographies of it—one by WILBERFORCE EAMES (1886) and one by JOHN FERGUSON (1929).

(*Columbia University Library*) BERTHA FRICK.

Petrus Camper.—April 7, 1789—150th Anniversary of the Death of PETRUS CAMPER.

Lectori Salutem !

The Faculty of Medicine of the University of Groningen has the honour to inform you that it intends, in collaboration with the Society " Het Nederlandsch Tijdschrift voor Geneeskunde " (*Netherlands Journal of Medicine*) and the Society for the History of Medicine, Mathematics and Natural Science, to commemorate on April 29 and 30, 1939, the life and works of PETRUS CAMPER, who died a hundred and fifty years ago.

The commemoration of this great physician, anatomist, obstetrician and artist, who for ten years was professor of medicine at Groningen, will take place in a solemn session of the Senate of Groningen University, and be accompanied by an exhibition of the complete works and drawings made by CAMPER.

At the session of the Senate, which will be held in the Aula Academica of the University on Saturday evening, April 29, addresses will be given by Dr. B. W. TH. NUYENS, of Amsterdam, and by various professors of medicine at Groningen.

The exhibition to be held at the Academic Hospital at Groningen will be open to all those interested on April 29 and 30, and later if desired.

Here there will be brought together for the first time all the original drawings made by CAMPER with an artist's hand, both those in the fields of anatomy and raciology, and those of the many things he saw on his European journeys, all of them in the possession of the Library of the Netherlands Society for the Promotion of Medicine at Amsterdam, and of the University Library at Leiden.

At this exhibition there will also be displayed a number of preparations made by CAMPER and described or represented in his works, which by a happy accident escaped destruction in the fire of the Groningen University building in 1906.

On behalf of the Committee for this Commemoration,

J. L. B. ENGELHARD.
G. VAN RIJNBERK.
D. SCHOUTE.

Groningen, December 1938.
Secretariat : 63, *Oostersingel.*

Ernst Darmstädter (1877-1938). Historian of chemistry.

ERNST DARMSTÄDTER was born on January 13, 1877 in Mannheim ; he committed suicide in Munich on Nov. 12, 1938. (The number of suicides has enormously increased in Germany, especially among Jews.)

We reprint below the books and papers of his which were mentioned or reviewed in *Isis*. That bibliography is probably incomplete, but it is more than sufficient to give an idea of the extent and variety of his studies. DARMSTÄDTER was one of the leading historians of chemistry of our time. G. S.

Die Ginseng-Wurzel. *Pharma-Medico* 4, 6 p. (n.d.)

Die Alchemie des GEBER. Mit 10 Lichtdrucktafeln. X+202 S. Berlin, SPRINGER, 1922 (*Isis* 5, 451-55).

GIOVANNI ARTALDO, arcivesco di Trani. *Archivio di storia della scienza* 4, 241-44, 1923 (*Isis* 6, 153).

GEBER-Handschriften. (Vorläufige Mitteilung). *Chemiker-Ztg.* 48, 441-42, 1924.

Per la storia dell' " Aurum potabile." *Archivio di storia della scienza* 5, 251-71, 1924. (*Isis* 7, 322).

Die Alchemie. *Zeitschrift für kritischen Okkultismus und Grenzfragen des Seelenlebens* 1, 13-21, Berlin, 1925.

Die " GEBER "-Inkunabel Hain 7504. *Archiv für Geschichte der Medizin*, 16, 214-17, 1925. (*Isis* 8, 737).

Liber claritatis totius alkimicae artis. Bologna Cod. lat. 164 (153). *Archivio di storia della scienza* 6, 319-330, 1925 (*Isis* 9, 153).

Liber Misericordiae GEBER. Eine lateinische Übersetzung des grösseren

Kitâb al-raḥma. *Archiv für Geschichte der Medizin* 17, 181-97, 1925 (*Isis* 8, 737).

Vorläufige Bemerkungen zu den assyrischen chemisch-technischen Rezepten. *Z. f. Assyriologie* 36, 302-04, 1925.

Berg-, Probir- und Kunstbüchlein. Mit Bibliographie und 12 Abbildungen. (*Münchener Beiträge zur Geschichte und Literatur der Naturwissenschaften und Medizin*, H. 2/3). 111 p., München, Münchner Drucke, 1926 (*Isis* 10, 143).

Der Dichter der " Jobsiade," KARL ARNOLD KORTUM (1745-1824) als Arzt und Medizinhistoriker. *Archiv für Geschichte der Medizin* 18, 270-72, 1926.

GEORG AGRICOLA (1494-1555). Leben und Werk. (*Münchener Beiträge zur Geschichte und Literatur der Naturwissenschaften und Medizin*, H. 1). 96 p., 12 fig., München, Münchner Drucke, 1926 (*Isis* 10, 144).

Münchener Beiträge zur Geschichte und Literatur der Naturwissenschaften und der Medizin. Herausgegeben von ERNST DARMSTAEDTER unter Mitwirkung von H. BAALSS, H. DINGLER, F. M. G. DE FEYFER, H. FISCHER, H. KERSCHENSTEINER, K. KISSKALT, A. C. KLEBS, H. MARZELL, TH. PAUL, W. PRANDTL, H. SIERP, G. STICKER, K. SUDHOFF, R. TISCHNER, H. WIELEITNER, E. ZINNER. München, Münchner Drucke, 1926 (*Isis* 10, 252).

Assyrische chemisch-technische Vorschriften und ihre Erklärung. *Archiv für Geschichte der Mathematik, der Naturwissenschaften und der Technik* 10, 72-86, 3 fig., 1927 (*Isis* 11, 216).

BENVENUTO CELLINI und seine Abhandlung über die Goldschmiedekunst. *Kultur des Handwerkes*, 7. Heft, 226-31, Juni 1927.

Der babylonisch-assyrische Lasurstein. *Studien zur Geschichte der Chemie*. Festgabe E. O. v. LIPPMANN dargebracht, 1-8, 1927 (*Isis* 10, 218).

Eisenhärtung mit Pflanzen. *Geschichtsblätter für Technik, Industrie und Gewerbe* 11, 163-69, 1927.

Liber claritatis totius alkimiae artis als deren autor " GEBER " genannt wird. [Bologna, Cod. Lat. 164 (153)]. Liber I, cap. 11-27. *Arch. di storia d. scienza* 7, 257-66, 1926; 8, 95-103, 214-26, 1927 (*Isis* 10, 130).

Zur Geschichte des Äthers (Diäthyläthers). *Journal für praktische Chemie* 120, 74-88, 1928 (*Isis* 13, 168).

Antike Münzherstellung und Münzfälschung insbesondere die antiken " Subaeraten." *Archeion* 11, lxi-lxviii, 1929 (*Isis* 14, 556).

Subärate Münzen und ihre Herstellung. *Mitteilungen der Bayerischen numismatischen Gesellschaft* 47, 27-38, München, 1929.

Der Naturselbstdruck. *Philobiblon* 3, 373-79, 5 fig., 1930.

JOSEF BERRES (1796-1844), und die Bildätzkunst. *Reproduktion*, Nr. 7, 151-52, port., 1930.

PARACELSUS und die Einführung chemischer Präparate als Heilmittel. *Georg Sticker Festgabe*, 63-72, Berlin, SPRINGER, 1930.

ACHIM VON ARNIM und die Naturwissenschaft. *Euphorion* 32, 454-76, Stuttgart, 1931 (*Isis* 18, 474).

Arznei und Alchemie. Paracelsus-Studien. VII+77 p. (*Studien zur Geschichte der Medizin*, H. 20). Leipzig, BARTH, 1931 (*Isis* 17, 494).

Der Schierlingsbecher. *Medizinische Welt* 5, 4 p., 1931.

Ein Vorläufer der modernen Quarzlampen im Altertum. *Chem.-Ztg.* 55, 204, 1931.

Erinnerung an DARWIN. Antritt seiner Weltreise am 27. Dezember 1831. *Münchener medizinische Wochenschrift* 50, 2126-29, 1931.

HOHENHEIMS Archaeus-Lehre. *Acta Paracelsica*, 78-85, 1931.

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Niels Nielsen (1865-1931).

" NIELS NIELSEN wurde im Jahre 1891 Magister scientiarum, im Jahre 1895 promovierte er mit der Dissertation ' Om en Klasse bestemte Integraler.' Er war 1900-1921 Lehrer an dem Vorbereitungskursus der Polytechnischen Lehranstalt, 1903-06 Mitglied der Unterrichtskommission für Höhere Schulen, wurde im Jahre 1905 Docent an der Kopenhagener Universität, war Professor für Mathematik vom Jahre 1909 bis zu seinem Tode. NIELSENS umfassende wissenschaftliche Produktion liegt auf den Gebieten der Funktionentheorie und Zahlentheorie ; besonders sind seine Handbücher über spezielle Funktionen, z.B. Zylinderfunktionen und die Gammafunktion sowie seine Untersuchungen über BERNOULLIsche Zahlen hervorzuheben. Ausserdem interessierte er sich sehr für Geschichte ; er hat eine Übersicht über Arbeiten von dänischen Mathematikern herausgegeben und ein Buch über ' Französische Mathematiker während der Revolution ' verfasst. NIELSEN hat ferner Schulbücher sowie Lehrbücher über Funktionentheorie, Algebra und Zahlentheorie geschrieben, die während einer Reihe von Jahren im Unterricht an der Universität verwendet wurden. NIELSEN besass einen einzigartigen Fleiss und grosse Arbeitskraft ; sein Unterricht war von grossem Wissen geprägt und kann als ein erster Versuch charakterisiert werden, die dänischen Mathematiker an den von WEIERSTRASS eingeführten Gesichtspunkten teilnehmen zu lassen. NIELSEN wurde im Jahre 1914 Mitglied der Akademie der Wissenschaften, war in den Jahren 1910-17 Vorsitzender der Dänischen Mathematischen Vereinigung."

Dänischer Konversationslexikon-Artikel, übersetzt von HARALD BOHR. Vgl. auch Prof. BOHRS dänischen Vortrag : NIELS NIELSEN (Tale i Videnskabernes Selskabs Møde den 5. Februar 1932), mit einem Bildnis.

Die wichtigsten geschichtlichen Schriften NIELSENS folgen :

Matematiken i Danmark, 1528-1800 ; 1801-1908. København, Nordisk Forlag, 1910-1912.

Franske Matematikere under Revolutionen. København, B. LUNOS, 1927.

Géomètres français sous la Révolution. Copenhague, LEVIN & MUNKSGAARD, 1929 (*Isis* 16, 502).

Géomètres français du dix-huitième siècle. Ouvrage posthume publié par les soins de N. E. NÖRLUND. Copenhague, LEVIN & MUNKSGAARD, 1935 (*Isis* 26, 258).

Nach einem Leben, reich an Arbeit und Erfolgen, verstarb heute unser lieber Vater, Schwiegervater, Bruder, Großvater und Urgroßvater

Pg. Karl Sudhoff

Dr. med., Dr. phil. h. c., Dr. med. vet. h. c.,
Preußischer Sanitätsrat und Professor,
Sächsischer Geheimer Medizinalrat,
emer. ordentlicher Professor für Geschichte der Medizin
an der Universität Leipzig,
Ritter höchster Orden.

Leipzig, Werdau i. Sa., Essen (Ruhr), Salzwedel, den 8. Oktober 1938.
Stephanstr. 18

Else Herbrand, geb. Sudhoff
Dipl.-Ing. Ernst Sudhoff und Frau
Else, geb. Wentzler
Dr. med. Walther Sudhoff und Frau
Marianne, geb. Maiweg
12 Enkel und 5 Urenkel.

Die Trauerfeier findet am 12. Oktober 1938 um 11 Uhr im Krematorium des Südfriedhofes in Leipzig statt.
Kranzspenden an das Bestattungsinstitut Hellmann, Leipzig, Matthäikirchhof, erbeten.

Cinquième congrès international d'histoire des sciences, Lausanne, septembre 1940. (première circulaire).—Suivant la décision qui a été prise à Lisbonne (1934) et confirmée à Prague (1937), c'est Lausanne qui aura l'honneur, si la situation politique et sociale de l'Europe le permet, de recevoir le prochain congrès organisé par l'Académie internationale d'histoire des sciences.

Le Congrès, qui se tiendra sous les auspices, et avec l'appui de l'Université de Lausanne et du Conseil d'État du Canton de Vaud, aura lieu à la fin de septembre 1940.

Il comprendra diverses sections dont le nombre et la dénomination seront déterminés par la nature des communications qui y seront présentées. De même qu'à Prague une section est prévue pour l'histoire des sciences techniques, agricoles, et des industries alimentaires; une autre section sera réservée à la philosophie des sciences, dans la mesure où celle-ci se rattache à l'histoire de la pensée scientifique.

Les séances plénières et les travaux de section auront lieu en général le matin; les séances des diverses commissions se tiendront l'après-midi. Des excursions dans les environs de Lausanne (à des prix modestes) sont en outre prévues.

La carte de membre actif est fixée à 20 francs suisses, celle de membre associé, à 10 francs suisses.

Nous serons heureux de recevoir dès maintenant les adhésions, ainsi que le titre des communications présentées, de manière à donner dès la fin de cette année quelques précisions sur le programme.

Lausanne, mars 1939.

Le secrétaire perpétuel, ALDO MIELI. Le président de l'Académie et du Congrès, ARNOLD REYMOND.

Prière d'envoyer toutes les demandes, les adhésions et les communications concernant le Congrès, directement au Président du Congrès :

Mr. ARNOLD REYMOND, professeur à l'Université de Lausanne, *La Rouvenaz*, Avenue Cerisier, Pully Lausanne (*Suisse*).

Académie internationale d'histoire des sciences.—Dans les premiers jours de 1939 le secrétaire perpétuel de l'Académie a invité les membres effectifs à voter pour les nouveaux membres qu'il fallait élire cette année.

Il s'agissait de 3 membres effectifs (dont 2 selon les Dispositions transitoires des Statuts de l'Académie, et un pour remplacer M. SUDHOFF, décédé) et de 12 membres correspondants (dont 7 selon les Dispositions citées, un pour remplacer le membre correspondant qui sera élu à la

place de M. SUDHOFF, et 4 enfin pour remplacer MM. VON GYÖRY, LAGERCRANTZ, NALLINO et DARMSTAEDTER, décédés). La liste des candidats au titre de membre correspondant, établie selon les prescriptions des Statuts, ne comprenait que huit noms.

Les membres effectifs en charge en janvier 1939 étaient au nombre de 41. Ainsi au premier tour aucun candidat ne pouvait être élu s'il n'obtenait pas 14 voix. Au 3 mars 1939, jour fixé pour le dépouillement des bulletins de vote et la proclamation des élus, 35 membres avaient envoyé régulièrement leur vote; ainsi le nombre minimum prescrit s'élevait à 18.

N'ont pas voté : M. RÀDL, malade depuis plusieurs années; MM. ASIN et MILLÀS, habitant l'Espagne et qui, peut-être, n'ont pas même pu recevoir les circulaires qu'on leur avait envoyées; en outre MM. THORNDIKE, ARCHIBALD et BOLOGA. Tous les autres ont fait connaître leurs intentions.

Membres effectifs :

Le dépouillement des bulletins de vote a donné le résultat suivant : ARLINDO CAMILO MONTEIRO (*Portugal*), 35 voix; JOHAN ADRIAAN VOLLGRAFF (*Pays Bas*), 35; FR. JAGUARIBE DE MATTOS (*Brésil*), 24. Ces trois ont été proclamés élus. Suit PABLO F. SCHURMANN (*Uruguay*) avec 9 voix.

Membres correspondants :

Le dépouillement des bulletins de vote a donné le résultat suivant : EDUARDO GARCÌA DE ZÙÑIGA (*Uruguay*), 34 voix; NIELS V. HOFSTEN (*Suède*), 33; JOSÉ JOAQUIM IZQUIERDO (*Mexique*), 33; CHRISTOS PAPANASTASSIOU (*Grèce*), 33; ORJAN OLSEN (*Norvège*), 32; K. M. BYKOW (*U.R.S.S.*), 31; RAUL LEITÂO DE CUNHA (*Brésil*), 28; AFONSO DE FAIRA (*Brésil*), 27. Tous ces huit candidats ont été proclamés élus.

Le secrétaire perpétuel de l'Académie,
ALDO MIELI.

Institute of general semantics.—The *Institute of General Semantics* has been incorporated under the Illinois State Laws as a non-profit institution for Linguistic Epistemologic Scientific Research and Education and is now established at Chicago.

During 1938-1939 ALFRED KORZYBSKI, author of *Manhood of Humanity* and *Science and Sanity*, etc., will continue a series of seminar courses in General Semantics and Non-Aristotelian Systems which were inaugurated last summer at the Institute. The autumn and winter courses consist of the Evening Series meeting twice a week, Saturday Morning Series

and an Intensive Training Series during the academic holidays in December. Special lectures by KORZYBSKI and staff members of the Institute and the seminar courses next summer will be announced later.

In 1939, the Institute will begin a quarterly publication devoted to news, current related bibliographies, and articles on the application of General Semantics in the fields of science and general education. This quarterly and other informational material will be sent to those who become Members of the Institute.

At present we invite short articles and summaries of work which is being done in General Semantics and its various applications both personal and professional. These communications will be considered for possible publications and promptly acknowledged, but will not be returned.

We hope you will use the enclosed business reply card to indicate your possible interest in receiving further communications from the Institute. Please check the card to indicate your interest in the various activities of the Institute and in the classes of membership available for those who wish to participate in the application of General Semantics to problems of science and human orientations.

Please address all communications to the Executive Secretary, *Institute of General Semantics, 1330, East 56th Street, Chicago* (Telephone, Fairfax 3366).

Zentralblatt für Mathematik.—Da einer der Herausgeber des *Zentralblattes für Mathematik* gestrichen worden ist, ohne ihm, mir oder den andern Herausgebern Mitteilung zu machen, da ferner von mir verlangt wurde, bei der Verteilung der Referate andere als rein sachliche Gesichtspunkte zu berücksichtigen, habe ich die Redaktion des *Zentralblattes* niedergelegt. Allen meinen Mitarbeitern habe ich für ihre jahrelange ausgezeichnete Tätigkeit wärmstens zu danken und vor allem für das Verständnis, mit dem sie sich in die nicht immer bequemen Anforderungen gefügt haben, die an sie gestellt werden mussten.

Blegdamsveg 15, *København* O. NEUGEBAUER.
November 1938.

In confirmation of this statement, we may add that the American associates of NEUGEBAUER, namely R. COURANT (New York), O. VEBLEN (Princeton), and J. D. TAMARKIN (Providence, R. I.), have resigned; also the Danish representative (H. BOHR), and we believe the English one (G. H. HARDY). The associate editor who had been dropped by the publisher (SPRINGER) without notification to the editor was the illustrious Italian mathematician T. LEVI-CIVITA. At this writing (14. XII. 38), the only foreign representatives left on the committee are apparently

the Frenchman, G. JULIA and the Finn, R. NEVANLINNA. The *Zentralblatt für Mathematik* has ceased to be an international journal; it has certainly ceased to be a journal wherein mathematical activities are discussed and criticized without political bias. An unbiased international abstract journal for mathematics will probably be founded in America in the near future. R. C. A.

Personalia.—Dr. OTTO NEUGEBAUER, formerly of Göttingen and of Copenhagen, has been appointed professor of mathematics in Brown University. It is expected that his presence in America will stimulate considerably the study of the history of mathematics and astronomy. We trust that the climate of Rhode Island and the amenities of Brown will stimulate him to continue his astounding activities and make new discoveries.

At the council meeting of the History of Science Society held at the Palmer House, Chicago, Dec. 29, 1938, Dr. HENRY ERNEST SIGERIST was elected President of the Society for 1939. He is the thirteenth president of the Society. Dr. GEORGE SARTON was elected honorary president.

Reviews

Euclide.—*L'Optique et la Catoptrique.* Œuvres traduites pour la première fois du grec en français, avec une introduction et des notes, par PAUL VER EECKE. XLVII + 126 pp. DESCLÉE DE BROUWER et Cie, Paris-Bruges, 1938.

M. VER EECKE continues a series of French translations of ancient Greek mathematical works which now includes ARCHIMEDES, APOLLONIUS OF PERGA, DIOPHANTUS, PAPPUS, and others. EUCLID's *Optics*, our earliest treatise on the subject, falls somewhat short of the high quality of clarity and organization attained in the famous *Elements of Geometry*. It consists of seven axioms and 58 propositions. The axioms are based on the Pythagorean theory that vision is accomplished by rays of light emanating in straight lines from the eye, and they ignore the rival theory of the atomists, familiar to us from LUCRETIUS, that images emanate from the objects seen. The propositions themselves lie chiefly in the field of perspective. Only twenty, according to VER EECKE, pertain properly to what is now called optics. Their elementary character is revealed by the fact that only one group (25-27) touches on problems involving both eyes, and of problems arising from the anatomy of the eye they are quite unaware. The appearance of lengths, parallels, spheres, cylinders, cones from different points of view are explained geometrically. The last seven propositions deal with objects in motion, and one (51) VER EECKE justly signalizes as introducing the notion of relative motion for the first time in the history of science.

The volume includes THEON's redaction of EUCLID's *Optics* and also the *Catoptrics* traditionally but falsely ascribed to EUCLID. The latter deals with mirrors and reflection in 30 propositions. It shows that the angles of incidence and reflection are equal and explains the reversal, enlargement and reduction of images in plane, convex and concave mirrors. The ancients had no understanding of refraction. The experiment with an object on the bottom of a vessel, visible at an angle only after water is poured in, is mentioned irrelevantly among the axioms of the *Catoptrics*, but is not explained.

M. VER EECKE's translation is reliable, being based on an adequate knowledge of Greek and of optics and on an understanding of ancient

theory. His volume contains an introduction touching on the life and works of EUCLID and the history of ancient optics, and giving a readable résumé of the works translated with explanatory and appreciative comments. It also gives a bibliography which shows that these works were widely read in the 16th and 17th centuries. In one respect the introduction is slightly unsatisfactory, and that is the citation of antiquated or uncritical authorities. One of the several examples is on p. x, where VER EECKE, relying on a work dated in 1870, exaggerates EUCLID's dependence on his predecessors and overestimates the development of Egyptian geometry. A reference to HEIBERG's *Geschichte der Mathematik und Naturwissenschaften im Altertum* (1925) would have been more appropriate. It is a satisfaction that the translation itself is based on HEIBERG's excellent critical edition (1895) of the original Greek texts.

Indiana University. AUBREY DILLER.

H. N. Wethered.—*The mind of the ancient world.* A consideration of Pliny's *Natural History*. XVI + 302 p., frontispiece. New York and London: LONGMANS, GREEN and Co., 1937. Price $4.00.

The author of this modern survey of PLINY's great encyclopedia of the "mind of the ancient world" utilizes PHILEMON HOLLAND's (1601) translation instead of the more literal and exact one of BOSTOCK and RILEY (1855) published in the sombre colors of the Bohn Library. The reason for this earlier choice lies in the fact that it was written by the "translator-general" of his age, which was the Elizabethan. The first edition (1601) was published in the same year that *Hamlet* first appeared. SHAKESPEARE in fact was familiar with HOLLAND's translation. IAGO's remark in *Othello* "Like to the Pontic sea...ne'er feels the retiring ebb" comes directly from PLINY and Friar LAWRENCE's speech in *Romeo and Juliet* is redolent of PLINY's tribute to Mother Earth.

HOLLAND was peculiarly qualified for this translation, being himself a physician as well as an experienced translator of the Latin tongue and a practiced user of Elizabethan prose as exemplified in the King JAMES' version of the Bible (1611). HOLLAND's translation is characterized by a quality of rhythm and phrase peculiarly adapted to render the classics, and by a preservation of the popular tone of the original which PLINY himself states in his dedication of his *Natural History* to the Emperor VESPASIAN was "written to the capacity of vulgar people, for base commons, rude husbandmen, and peasants of the country." Hence the considerable attention paid to herbal medicine, domestic animals and cultivated plants. Doubtless also this aim of the author accounts in part for the latitude accorded the raconteur which PLINY so often used in including the marvellous along with the more serious and scientifically

more accurate data compiled in his voluminous 37 books. That PLINY accomplished his aim is manifest in the fact that for more than a millennium the *Historia Naturalis* had no competitor. Unlike most old manuscripts that of PLINY was never lost. It was one of the early books to be printed and rumor sayeth that for a time there were more editions of PLINY extant than of any other book except the Bible. This very interest in the book led to the introduction of glosses at the hands of copyists and may have contributed to the alleged difficulties of reading PLINY's Latin.

It was intended as an encyclopedia of all knowledge, i.e. *historia* in the Latin sense, with, wherever possible, a fund of anecdote to enliven the otherwise arid continuity of mere facts.

The *Natural History* has preserved for us a picture of the wonders of the world which seized and colored the imaginations of the Greeks and the Romans. Vast and diffuse as it is, it still contains a more authentic account of the customs and thought of classic times than many a modern attempt at their reconstruction. PLINY was an authentic eye-witness, of a cultured family, a traveller, soldier, administrator, an omnivorous reader, and above all a man of stupendous industry as revealed in the letters of PLINY, the younger.

In his work one sees the typically practical point of view of the Roman people and their keen appetite for the curious and marvellous, along with a presentation of Greek science with its wealth of observation, analysis, and theory.

The author has gathered from the 37 books for running comment and criticism nearly 500 selections which are quoted with only slight modernization from HOLLAND's text. These are grouped under the headings of man, the body and physic, animals, fabulous creatures, birds, fishes, insects, flowers and herbs, inventions, magic and religion, gold and silver, precious stones, painters, sculptors, architecture and the seven wonders, the universe, and places and peoples. An introductory chapter gives a brief biography of PLINY and an account of HOLLAND and his translation. The first of the three appendices deals with mediæval natural history, mainly with Bestiaries and RABELAIS' humorous caricature of them, which, doubtless, in part is one of the sources of the supercilious contempt sometimes transferred to PLINY. The second treats of ancient science in literature, principally with the fantastic *Travels of Sir John Mandeville*, the romances of chivalry and euphuism, and SHAKESPEARE's use of ancient science. This great writer seems to have absorbed little of the new science which was beginning to emerge about him. The third appendix lists the chapter and page of the quotations in the text from Holland's translation.

The author's treatment of this interesting subject is marked by two features. The first is an effort to free PLINY from the charge of credulity by citations of his critical comment on the untruthfulness or lack of confirmation of some of the accounts of so-called natural phenomena which he relates. These range from his caustic comment on biting off a puppy dog's tail to cure rabies to a sober statement that insects have no bones as reputed. When these are all summed up along with PLINY's own statement of his aim, the author makes a pretty good case for the critical acumen of the Roman encyclopedist. On the other hand there still remains much which may be regarded as chaff in the two senses of the word, mingled with the precious grain.

The second whimsey of the writer is to pick out in PLINY's writings the possible origin, at least proximate, of oft-quoted phrases such as " in a nutshell " based on PLINY's account of a man whose eyesight was so keen that he wrote the whole of the *Iliad* on a piece of parchment so small that it could be enclosed in a nutshell. Honors and dignities conferred on brave men were called " salaries " because salt whets the appetite.

Both HOLLAND's and BOSTOCK and RILEY's translations of PLINY, the only ones in English, are rare and not often accessible except in large libraries. The author has rendered a distinct service to all interested in the history of science in making available a finely selected sample of his writings and in critically commenting on them.

CHARLES A. KOFOID.

Leon Battista Alberti (1404-1472).—*De re aedificatoria libri decem.* In two volumes. Vol. I : Text. XXIX+391 p., portr., facs., figs. Vol. II : Materials and commentaries. XV+794 p., portr., facs., figs., folding plates. Classics of the theory of architecture. Moscow, All-Union Academy of Architecture, 1935 and 1937. (In Russian). (Cloth, 17.50+30.00 rbls.).

When the first volume of this monumental work on architecture was published, in 1935, a review in *Isis* 26, 158-59, gave some data on its contents and on the early editions and translations of the text of *De re aedificatoria*. The second volume lived up to the expectations of this reviewer; until Western students of ALBERTI produce a similar edition, this Russian publication will remain the greatest tribute paid to the great Italian by our contemporaries. The collection of the Classics of the theory of architecture, appearing under the general editorship of A. G. GABRICHEVSKI, promises to make the publications of the All-Union Academy of Architecture as indispensable to Western libraries as the

publications of the Institute for the History of Science and Technology of the USSR Academy of Sciences.

There is no critical edition of the Latin text of ALBERTI's *De re aedificatoria*. The text of the three Latin editions (Florence, 1485; Paris, 1512; and Strasbourg, 1541) has often taxed the ingenuity of the translators and commentators. Four Latin MSS are available in Italy : Plut. XXXIX, cod. 113 in the Laurentiana, cod. Urbin. lat. 264 and cod. Ottobon. lat. 1424 in the Vatican, and Bibl. Estense 419 in Modena. A critical edition of the Latin text of the treatise would be a fitting tribute to a great Italian of the quattrocento by the builders of the new Roman Empire.

The translator of the text, V. P. ZOUBOV, has contributed the excellent commentary (p. 263-681); it will be noticed that this commentary occupies more than half of volume II, and that its fine type offers more reading matter than the well-translated text of the treatise in volume I. ZOUBOV's commentary is both critical and exegetic. He has studied the various editions and translations, and his comments on the readings he adopted for his own translation will have to be taken into consideration by future editors and translators of *De re aedificatoria*. He has studied the sources of ALBERTI, and his commentaries help us to appreciate the learning of ALBERTI. ZOUBOV's commentary is illustrated by 166 figures which add to the attractiveness of this part of volume II.

Volume II contains two biographical sketches of ALBERTI : one by GIORGIO VASARI, translated by A. G. GABRICHEVSKI, the other by A. I. BENEDIKTOV. Six minor treatises or fragments of works by ALBERTI are given in translations, from the Latin or from the Italian, made by GABRICHEVSKI (4 items) and by ZOUBOV (2 items); these translations (p. 11-120) are followed by ZOUBOV's bibliographical and exegetic notes (p. 121-132). ALBERTI's *Ludi mathematici* (p. 67-100, with 29 illustrations) are of especial interest to the historian of science.

Volume II contains three valuable papers on ALBERTI : " ALBERTI and the culture of the Renaissance " (p. 157-183), by A. K. DJIVELEGOV; " ALBERTI the architect " (p. 185-233, with 38 illustrations), by A. G. GABRICHEVSKI; and " Sources of the treatise *De re aedificatoria* " (p. 235-261), by V. P. ZOUBOV.

Relevant passages from the works of DIODOROS OF SICILY, COLUMELLA, VARRO, PLINY THE YOUNGER, ALBERTUS MAGNUS, PIER DEI CRESCENZI, GIOVANNI ANTONIO CAMPANI, FRANCESCO PATRIZZI, and GIANOZZO MANETTI, translated by ZOUBOV, and a fragment from a diary of FRANCESCO RUCELLAI, translated by GABRICHEVSKI, are given in the Addenda (p. 685-738). A short treatise, " On the five orders of architecture," attributed to ALBERTI, is given in the Addenda (p. 738-42, with 3 folding

plates), in GABRICHEVSKI's translation. Numerous useful lists are found in the Addenda : emendations in the Latin text; ALBERTI's writings; bio-bibliographical data on the authors whose works were mentioned or used by ALBERTI; tables of weights and measures; a bibliographical list ; index of persons, geographical index, subject index ; errata, etc.

The literature on ALBERTI is very extensive; this Russian publication is not merely an addition to this literature; no Western student of ALBERTI can afford it to disregard the existence of volume II. The illustrated commentary, by ZOUBOV, and his monograph on the sources of ALBERTI deserve to be translated into a Western language and to be used in conjunction with the available vernacular translations of *De re aedificatoria;* the scholars who will have to prepare, eventually, a critical edition of the Latin text of the treatise, will have to get acquainted with the work done by ZOUBOV.

Typographically, the two volumes are high above the usual product of the Russian presses; the type is beautiful; the paper is good; the illustrations are remarkably well reproduced; even the bindings seem to be durable. A. P.

Abyssinia.—*The discovery of Abyssinia by the Portuguese in 1530.* A facsimile of the relation entitled *Carta das novas que vieram a el Rey nosso Senhor do descobrimento do preste Joham* (Lisbon 1521), with an introduction and English translation and notes by HENRY THOMAS, and a transcription into modern Portuguese by ARMANDO CORTESÃO. XV+98 p., facsim., 2 maps. London, British Museum, 1938. (Bound, £ 1 2s. 6 d.).

The *Carta das novas*, printed in Lisbon, in 1521, (see Fig. 1) remained unknown to historians and to bibliographers until November, 1935, when it was entered in an auction sale catalogue by SOTHEBY and Co. The acquisition, by the British Museum, of this earliest printed first-hand account of XVIth-century Abyssinia, at a time when the Italian conquest of Abyssinia was gathering momentum, forms a dramatic incident the details of which will be found in the Prefatory Note. Until November, 1935, the earliest printed first-hand account of XVIth-century Abyssinia, known to scholars, was the *Verdadera informaçam das terras do Preste Joam*, by FRANCISCO ÁLVARES, published in 1540.

The book under review consists of an unsigned Prefatory Note (p. V-VI), of HENRY THOMAS' Introduction (p. IX-XV), of the Facsimile of the *Carta das novas* (p. 3-30), of ARMANDO CORTESÃO's Transcription into modern Portuguese (p. 33-59), of HENRY THOMAS' English Translation (p. 63-92), of Notes contributed, apparently, both by CORTESÃO and by THOMAS (p. 95-98), and of two maps. The beautiful frontispiece map

reproduces " an early Portuguese representation of the Red Sea district, from sheet eleven of the Portolano of FERNÃO VAZ DOURADO, circa 1570 "; the map at the end of the volume is a " sketch map of the Red Sea and Gulf of Aden, to illustrate the *Carta das novas*."

The legendary Prester JOHN began to acquire a historical personality

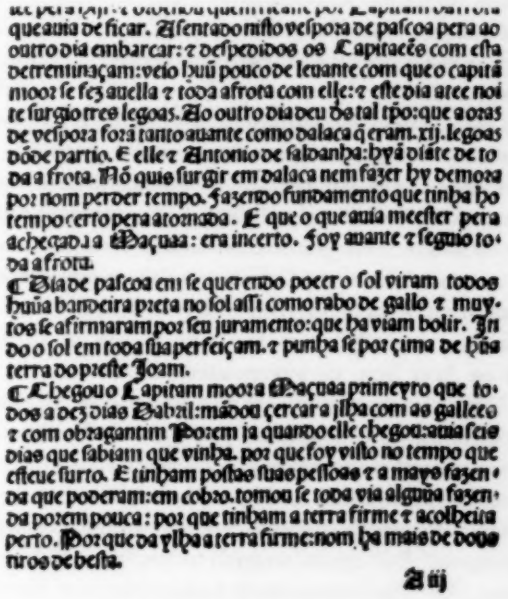
Carta das nouas q̃ vieram
a el Rey nosso Senhor do de
scobrimento do preste Johã.
Impressa por mandado De
su alteza. Com preuilegio.

FIG. 1
Carta das novas. Lisbon, GERMÃO GALHARDE, 1521.
(Original, ca. 14×22.5 cm.)

in the XVth century. In 1427, two emissaries from Abyssinia reached the King of Aragon. Not later than 1446, Prince HENRY the Navigator established contact with Abyssinia, via Egypt; a few years later, he received Abyssinian emissaries in Lisbon. In 1487, AFONSO DE PAIVA and PEDRO DA COVILHÃ were sent to Abyssinia; they succeeded in crossing from the Mediterranean to the Red Sea; AFONSO DE PAIVA soon died, but PEDRO DA COVILHÃ finally reached the court of Prester JOHN, in 1494; he settled

down in Abyssinia and was found there by the Portuguese embassy of 1520.

The discovery, in 1497, of the sea route to India by VASCO DA GAMA made India rather than Portugal the base of expeditions to the Red Sea. In 1508, two Portuguese emissaries reached the Abyssinian court, asking for supplies and men; the Turks were a menace both to the Abyssinians and to the Portuguese in India. The favorable reply of the Abyssinian court, contained in a letter which reached Lisbon in 1514 and which is reproduced, in a Portuguese translation, at the end of the *Carta das novas*, was sent by the ambassador MATTHEW, an Armenian related by marriage to the imperial family. MATTHEW left for Portugal, via India, in 1509,



que auia de ficar. ℭ Sentado nisto vespora de paſcoa pera ao outro dia embarcar: ⁊ deſpedidos os ℒ apitaẽs com eſta determinaçam: veio huũ pouco de leuante com que o capitã mooꝛ ſe fez auella ⁊ toda afrota com elle: ⁊ eſte dia atee noi te ſurgio tres legoas. ℭ o outro dia deu ỏ tal tpo: que a oras de veſpoꝛa foꝛã tanto auante como dalaca q̃ eram. xij. legoas dõde partio. ℭ elle ⁊ Antonio de ſalbanha: hyã diãte de to da a frota. ℕõ quis ſurgir em dalaca nem fazer hy demoꝛa poꝛ nom perder tempo. ℑ azendo fundamento que tinha ho tempo certo pera atomada. ℭ que o que auia meeſter pera achegada a ℳaçuaa: era incerto. ℑ oy auante ⁊ ſeguio to da a frota.

ℭ Dia de paſcoa em ſe querendo poeꝛ o ſol viram todos huũa bandeira preta no ſol aſſi como rabo de gallo ⁊ muytos ſe afirmaram poꝛ ſeu juramento: que ha viam bolir. ℑn do o ſol em toda ſua perfeiçam. ⁊ punha ſe poꝛ çima de hũa terra do preſte Joam.

ℭ Chegou o ℒ apitam mooꝛ a ℳaçuaa primeyro que todos a dez dias Babal: mãdou çercar a jlha com as galleco ⁊ com obragantim ℙoꝛem ja quando elle chegou: auia ſete dias que ſabiam que vinha. poꝛ que foy viſto no tempo que eſteue ſurto. ℭ tinham poſtas ſuas peſſoas ⁊ a mayo fazenda que poderam: em cobro. tomou ſe toda via alguũa fazenda poꝛem pouca: poꝛ que tinham a terra firme ⁊ acolheu poꝛto. ℙoꝛ que da ylha a terra firme: nom ha mais de dous tiros de beſta.

ℭ ij

FIG. 2

Interpolated description of the solar eclipse of 1520 April 17.
(Original lines, ca. 12.5 cm.)

reached Lisbon in 1514, and his return to Abyssinia in 1520, described in the *Carta das novas*, forms the final link in the " descobrimento do preste JOHAM "—during his years of association with the Portuguese both in India and in Portugal, MATTHEW was under the suspicion of being an impostor.

The expedition of 1520, the final embassy to Prester JOHN, sailed from

India on February 13 of that year; the Governor, DIOGO LOPES DE SEQUEIRA, was in command of the fleet of twenty-four sail and of one thousand eight hundred men. This expedition not only returned MATTHEW to Abyssinia but also established permanent relations with the Emperor's court; the ambassador, RODRIGO DE LIMA, was accompanied by Father FRANCISCO ÁLVARES, who remained in Abyssinia until 1526 and who wrote the *Verdadera informaçam das terras do Preste Joam*, published in 1540. Another member of the expedition of 1520 whose literary efforts have been preserved to posterity was the licentiate PERO GOMES DE TEIXEIRA, the auditor, " who was present at everything in person."

The *Carta das novas* is based on the " news " which reached Lisbon on the last day of the month of April, 1521, in two reports; Governor DIOGO LOPES DE SEQUEIRA, referred to as " Captain-major " in the *Carta das novas*, and the licentiate PERO GOMES DE TEIXEIRA, referred to as the " Auditor," were the authors of these two reports. The Captain-major was chiefly interested in the naval, military, political, and diplomatic aspects of the expedition; the Auditor was, apparently, a pious man who was interested in theology, religious art, and the price of commodities. Neither the authors of the reports nor the unknown Lisbon editor of the *Carta das novas* possessed literary ability. The contents rather than the form of the *Carta das novas* make this book a welcome addition to the relations of voyages of discovery. Some problems presented by the text deserve the attention of students with widely differing points of approach. Thus, one passage, reproduced in facsimile in Fig. 2, suggested to this reviewer that we have here an interpolated reference to the solar eclipse of 1520 April 17. Interpolations are not rare in the *Carta das novas*—thus, the repetitions, contradictions, passages of the " como dito he " type, etc. prove that the editing was done somewhat carelessly. In the case of the passage reproduced in Fig. 2, the omission of the interpolated paragraph, " Dia de pascoa... preste Joam," would reestablish the continuity of the story, " Foy auante e seguio toda a frota. Lhegou o Capitam moor a Maçua..." The interpolated paragraph,

> " On Easter-day, as the sun was about to set, they all saw a black flag over the sun just like a cock's tail, and many swore on oath they saw it move, as the sun was setting in all its glory; and it set over a land of the Prester John ",

obviously describes a remarkable celestial phenomenon witnessed by the sailors and soldiers off Massawa. Now, on April 17, 1520, there was a total eclipse of the sun; the path of totality crossed central Africa, and the eclipse was not, for this reason, listed in the European yearbooks; off Massawa, the eclipse reached a maximum phase of 0.43, about 8 minutes before sunset; an eclipse at sunset is very conspicuous even if less than

0.4 of the solar diameter is obscured; as seen from the red Sea, off Massawa, the eclipsed sun was setting, on April 17, 1520, over the land of Prester JOHN, and the moon was encroaching on the left limb of the sun, just like the curved tail of a cock or like a black banner. Easter fell, in 1520, on April 8; the eclipse occurred on April 17; the fleet remained off the coast of Abyssinia throughout the month of April. The eclipse occurred on a Tuesday, and a Tuesday (of the octave of Ethiopian Easter) is mentioned three pages from the interpolated passage; is a lapsus memoriae or a deliberate attempt to record a quasi-miracle on an Easter Sunday responsible for the confusion of dates?

The *Carta das novas* ends with a Portuguese translation " of the letter which the Prester John sent to the King our Lord by his ambassador Matthew in the year fifteen hundred and fourteen." This letter (sent in 1508, delivered in 1514) has been known to scholars through a Latin translation which appeared in the *Legatio magni Indorum imperatoris Presbyteri Ioannis ad Emanuelem Lusitaniae regem...* by DAMIÃO DE GÓIS (Antwerp, 1532). One of the Notes, at the end of the volume under review, proves that the Latin version is based on the printed Portuguese version of 1521. Other early historians have used the *Carta das novas*, without mentioning it. Now that the text of the *Carta das novas* is available, historians, geographers, theologians, astronomers, etc. may add their share to the very interesting Notes which appear at the end of this stimulating volume.

A. POGO.

J. F. Scott.—*The mathematical work of* JOHN WALLIS, D. D., F. R. S, (1616-1703). With a foreword by E. N. DA C. ANRADE. XI+240 p., figures, facsimiles, portrait. London, TAYLOR and FRANCIS, 1938. 12s. 6d.

Dr. SCOTT's treatise is most welcome as there is a certain strategic necessity for detailed analysis of WALLIS' work. For, to quote Dr. SCOTT, WALLIS' " career was extraordinary in many ways, and not the least of these is the light it throws upon the temper of the world in which he lived. Although it was never granted to him to enrich the world of learning with some outstanding discovery, WALLIS more than once pointed the way to what proved to be new and untraversed realms of thought." One or two examples will suffice to demonstrate this. In the *Arithmetica Infinitorum* (1656), WALLIS attempted to solve the problem of the quadrature of the circle by the method of Interpolation. (The word " Interpolation " is due to WALLIS.) The chief obstacle that WALLIS failed to surmount in this problem was the disposition of the fundamental series $(\sqrt[p]{R} - \sqrt[p]{a})^n$ which "he knew would have $n + 1$ terms so long as n was a positive

integer. If n were $\frac{1}{2}$, as the quadrature of the circle demanded, the emergent expression would have 'more terms than one, and less than two,' and even his genius could not see how this *impasse* could be avoided." The considerations of this difficulty later led ISAAC NEWTON to the discovery of the Binomial Theorem. Or, consider the relation arrived at by WALLIS in the course of the same investigation, which we now call WALLIS' Formula :

$$\frac{\pi}{2} = \frac{2.2.4.4.6.6.8.8.\ldots.}{1.3.3.5.5.7.7.9.\ldots.}$$

and which he expressed also in the form :

$$\frac{4}{\pi} = 1 \times \frac{9}{8} \times \frac{25}{24} \times \frac{49}{48} \times \frac{81}{80} \times \frac{121}{120} \times \ldots.$$

WALLIS, unsatisfied by this result, induced his friend Lord BROUNCKER (the first president of the Royal Society) to investigate the problem. The latter had no better success than WALLIS in getting an absolute value, but he did get the beautiful result

$$\frac{\pi}{4} = \cfrac{1}{1 + \cfrac{1}{2 + \cfrac{9}{2 + \cfrac{25}{2 + \cfrac{49}{2 + \text{etc.}}}}}}$$

According to CAJORI, although continued fractions were known to the Greeks and the Hindus, BROUNCKER's expression marks the birth of the modern theory of continued fractions. (For further details see Chapter IV of Dr. SCOTT's book.) It is clear that these two important results had their genesis in WALLIS' work.

Of the eleven chapters in the book, Dr. SCOTT devotes five to detailed analysis of WALLIS' mathematical works, showing in each case the relation of WALLIS' actual achievement to the work of his predecessors, his contemporaries, and his successors. It was WALLIS who first effected a synthesis of the method of Indivisibles (as developed by ROBERVAL, FERMAT, TORRICELLI, and CAVALIERI) and the methods of analytical geometry. His treatise on conics was the first systematic exposition of the application of Cartesian methods to the theory of conic sections as a whole. But what is perhaps of most interest is the *Treatise of Algebra* (1685, in English). The first section of this work is historical and although the portion of the historical section devoted to the ancients is quite remarkable for its time, the portion devoted to his own century

is one of the greatest distortions in the history of the history of science. For WALLIS takes the point of view that all the major mathematics of the seventeenth century was developed by Englishmen, and that, for example, DESCARTES plagiarized from HARRIOT. Dr. SCOTT analyzes all of the major statements of WALLIS and compares them with statements of other historians, finally to judge WALLIS as falling far short of the standard he had set himself in the introduction to the *Algebra*. Rather than condemning WALLIS outright, Dr. SCOTT prefers to quote the condemnations of other historians such as CANTOR and MONTUCLA, showing, however, that WALLIS' prejudice was directed chiefly against the French mathematicians who, in WALLIS' opinion, had paid but scant attention to British mathematics. According to Dr. SCOTT it was this, coupled with WALLIS' great fear of plagiarism that caused the distortion. (In support of this opinion he quotes the following excerpt from one of WALLIS' letters : " I could wish that those of our Nation were a little more forward... in timely publishing their own discoveries and not let strangers reap the glory of what those amongst ourselves are the authors.") What is more likely to be the case is that WALLIS was embittered against the French mathematicians as a result of the long controversies in which he had been engaged with FERMAT and others of the French school. Dr. SCOTT is a little naive in his approach to the seventeenth century, essentially a century marked by violent controversies. It may, for example, seem strange to *us* to find WALLIS and HOBBES engaged in vitriolic controversy over mathematical questions, as a result of their disagreement on theological questions, but such action would certainly not have seemed strange to anyone living at the time.

In conclusion, it must be said that Dr. SCOTT takes great pains to make clear WALLIS' remarkable contributions to the development of modern mathematical nomenclature and notation. It is to WALLIS that we owe the symbol ∞ for " infinity ", the symbol $\leqslant$ for " less than or equal to," the name " hypergeometric series " for the series whose general term is $\frac{1.3.5.....(2n+1)}{2.4.6.....2n}$, etc. This is made especially plain by the set of facsimiles of pages from the works of WALLIS and those of his contemporaries, which forms the first appendix to the book. Another appendix consists of 37 pages of paragraph biographies of most of the persons mentioned in the text, " except BOYLE, DESCARTES, FERMAT, GALILEI, LEIBNIZ, NEWTON and PASCAL " who " are sufficiently familiar to the reader as to render their inclusion in the following pages unnecessary." It is strange indeed that Dr. SCOTT should believe that such noteworthies as HUYGENS HALLEY and HOBBES are not so " sufficiently familiar." The book is indexed and contains a list of the papers published by WALLIS in the

Transactions. It is to be regretted that instead of giving a similar list of the mathematical treatises, Dr. SCOTT lists only the table of contents of WALLIS' *Opera* (1693-99). This omission makes incomplete what is in all other respects a complete, accurate, and interesting study.

Harvard University. I BERNARD COHEN.

Hester Hastings.—*Man and beast in French thought of the eighteenth century*. Inaugural Dissertation, Johns Hopkins University. Reprinted from Johns Hopkins Studies in Romance Literature and Languages, Vol. 27, 297 p. 1936. Price $ 1.25.

This dissertation completes a trilogy on the growth of humanitarian feeling toward animals in the period of its formulation. The other two are HARWOOD's (1928) *Love for Animals and How it Developed in Great Britain* and BOAS's (1933) *The Happy Beast in French Thought in the Seventeenth Century* (*Isis* 22, 240). The movement culminated in the legislation of the nineteenth century against cruelty to animals and the revulsion against vivisection. Other factors not envisaged in any of these treatises, which were based largely on *belles lettres* and philosophical discussions, were the rise in interest in animal industry, improvement in breeds, increase of interest in pet animals, especially dogs and cats and the diversification of their breeds, resulting in part from changes in hunting methods and from importations in connection with exploration and increase in travel. BUFFON's *Histoire Naturelle* both reflected this growth of popular interest in animals and contributed to it. The extended account of domesticated animals in BUFFON's work and in agricultural encyclopedias which preceded it such as those of MARKHAM and of LIGER reflect this widespread and not unintelligent interest in domestic animals and their proper care. DAUBENTON's *Advice to shepherds* is a specialized case of such interest. BUFFON, however, did not sentimentalize over any animals and was rather obtuse to aesthetic qualities. His interest lay rather in their activities.

The place of beasts in man's thinking has been interwoven with philosophic and religious thought about man himself. The question of the brute's soul and its immortality impinges directly on those of man. Thus BONNET (1779-1783) expressed a belief in a future life for the beasts.

The relative positions of beast and man in the scale of perfection were involved in the concepts of the " noble savage " and perforce " the happy beast " of those who oppressed by the miseries of human civilization and ignorant of nature red in tooth and claw, concluded that humanity was not only miserable but degenerate and degraded. On the other hand a more objective and observant group, supported by the tenets

of religion and philosophy, advocated the superiority of man and were in some cases willing to concede that beasts were automatons even devoid of feeling. However, LA METTRIE's (1748) exaggerations, VOLTAIRE's irony, the serious writings of RIVAROL, and LEROY's (1762-1781) letters on the perfectibility and intelligence of animals, helped toward the liberal and sensible view that animals share the physical, emotional, and sometimes the mental activities of man but yet remain inferior. Speculation extended consideration to opinions on the soul, emotions, and virtues of the beasts, but did not lead to a critical study of animal behavior.

The sounder appreciation of animals fostered human sympathies for them expressed in revolts of FREVILLE (1796) and LAVALLÉE (1803) against cruelty to dogs and other domestic animals, and against vivisection. Even vegetarianism appealed to this rising sympathy for animals as emotionalism came more and more to the fore. However, it was not until the following century that humane societies and legislation against cruelty to animals emerged. An exaggerated form of this emotionalism largely centered about spinsters' cats and dogs is responsible for endowments and agitation against the use of animals in legitimate scientific investigation in the interests of the welfare of both man and beast. It is a serious menace to the progress of experimental biological sciences.

CHARLES A. KOFOID.

Gilbert Chinard.—*Voyage de Lapérouse sur les côtes de l'Alaska et de la Californie* (1786) *avec une introduction et des notes.* Historical Documents, Institut Français de Washington, Cahier X. LII + 144 p., 22 pls. Baltimore: The Johns Hopkins Press, 1937. Price $3.00.

This work contains the original text of those parts of the *Voyage* of LAPÉROUSE of the edition of 1797 which concern the northwest coast of America and the coast of California together with the notes by LAPÉROUSE, those of MILET-MUREAU who edited the *Voyage*, and of the author of this account. The illustrations include 20 plates reproduced from the atlas supplemented by the pertinent part of the large original map and by a plate representing the reception of LAPÉROUSE and his staff by the priests and Indian neophytes of the Franciscan Mission at Carmel painted by an artist of the French expedition for the Mission and known to be in existence in 1827 but which in 1839 mysteriously disappeared. Fortunately a copy of it was made in 1791 by an artist who accompanied MALASPINA to Monterey. This copy was discovered by H. R. WAGNER and is here reproduced.

The author sketches the career of LAPÉROUSE and analyzes his character as an officer of exceptional ability as shown by the exactness of his accounts

of the expedition, the accuracy of his surveys and maps, and the sustained health of the members of the staff and crew.

Under the personal concern of LOUIS XVI, the expedition was outfitted carefully with royal instructions to avoid offense to other powers, to win the friendship of the chiefs of the native peoples visited, to maintain with prudence a complement of men sufficient to provide superiority over any mob of natives, and to avoid the necessity of the use of force. The program of the expedition was carefully planned as a peaceful scientific enterprise. To this end LAPÉROUSE who had distinguished himself by his humanitarian treatment of the English traders in his victorious Hudson Bay expedition, was chosen as leader. From the writings of LAPÉROUSE one sees that he had no illusions about the " noble savage " such as were popular in his day among French nature philosophers, neither was he unaware of the limitations of the Franciscan cultural regime as he saw it in its crude form in the newly founded mission at Carmel. He took pains to leave with the padres seeds, tools, and an improved mill for grinding corn. It is also evident that the malodorous and unsanitary conditions of life among the Alaskan natives at the Port du Français deeply offended his civilized temper of mind.

The scientific enterprises of the expedition were also planned with scrupulous care, beyond that of any other voyage of the eighteenth century. The instructions and preparations for the voyage are in themselves a picture of the actual state of French science at that period (1784) and of the then prevalent trends in the various sciences. The savants of the Paris Academy of Sciences, the Academy of Medicine, and the Jardin des Plantes all contributed instructions for the staff of the expedition. The itinerary was planned to solve the enigma of the Austral Continent, and to visit mysterious Easter Island, New Holland, and New Zealand. With an eye to an opening in the profitable China trade in the fur of the sea-otter the Alaskan coast was to be inspected for a location of a French center of activity and a possible northwest passage, and California was to be visited to view the Russian-Spanish scene. The instructions of the Academy of Sciences were presented by CONDORCET. They included directions for observations on the pendulum, longitude, tides, declination of the compass, barometric and atmospheric conditions, the use of balloons for the study of currents of the air, temperatures of the sea at different depths, icebergs, and phosphorescence of the sea. The nature of the air was to be determined according to the methods of LAVOISIER who also provided " *une pèse-liqueur très sensible* " for determination of the specific gravity of sea water, and chemical reagents for the analysis of its contained salts.

The medical and anthropological instructions were most detailed and

elaborate. They included an extensive plan for anthropometric measurements, records of modes of life, diet, clothing, baths, condition of the air and its electrical state, scurvy, rickets, venereal diseases, treatment of hernia, fractures, and wounds, native surgical instruments and medicaments, and animal and vegetable poisons. The medical instructions were signed by MAUDUY, VICQ D'AZYR, FOURCROY, and THOURET.

The botanical plans included distribution of seeds, plants, and young trees, as well as the collection of the local floras. The zoological outline stressed comparative anatomy. The library was supplied with scientific books and reports of voyages. The laboratory was equipped with instruments from French and English instrument makers, and was provided with two microscopes.

The *Boussole* and *Astrolabe* set sail for further explorations in Australasia from Botany Bay in February, 1788 and were never heard of again till twenty-five years later when their wrecks were found on the coral reefs of Vanikoro. The reports of LAPÉROUSE which reached France from the expedition up to this date were not published until 1797. As a result the priority of LAPÉROUSE's geographical discoveries was in part lost.

The Alaskan and Californian text of the *Voyage* is supplemented in this work by the section of the geographical results, by ROLLIN's physiological and pathological memoir, and by the correspondence of LAPÉROUSE and DE LANGLE with the Marine office at Paris.

The author has provided a valuable document in the history of science in his account of LAPÉROUSE, the equipment of the expedition, its origin and aims, and its scientific plans and accomplishments.

C. A. KOFOID.

John James Audubon.—*Birds of America.* With an introduction and descriptive text by WILLIAM VOGT. XXV p., 500 colored pls., portrait frontispiece. New York: The MACMILLAN Company, 1937. Price $12.50. Limited Edition on rag paper $25.00.

Beyond all question the outstanding figure both in early American natural history and in the artistic representation of its wild life is JOHN JAMES AUDUBON, the artist-naturalist (1780-1851). The work upon which his fame grew and still rests was his magnificent *The Birds of America, From Original Drawings* (1827-1830) in elephant folio form, engraved and printed in England in successive parts over a period of four years in an edition of less than two hundred copies at a price of one thousand dollars per set. Many of these sets were broken up and a few of the plates still appear in the market but a perfect set, if obtainable, would command a fabulous price.

The present edition comprises the 435 illustrations of the original elephant folio edition and 65 additional ones which AUDUBON did at a later date after he had the opportunity to acquire and paint birds of the Rocky Mountain region and the Far West. These plates, numbers 436-500, were published in the octavo *Birds of America* (1840-1844) published by AUDUBON in New York and Philadelphia. A perfect set of the folio edition owned in America was loaned by the owner for use in making the plates for this edition. The plates are about one-fourth the size of those in the folio edition and are reproduced by the photographic color-printing process. The publishers, engravers, and printers are to be congratulated on their enterprise and technical skill. Their product easily ranks in the forefront of works illustrated in color by these methods. Its magnitude, involving a million impressions, its cost, easily a million dollars, and the technical difficulties overcome in the registration and impression of the successive printing of the colors on the same sheet, are such as to daunt all but those willing to take heavy risks and to overcome a sequence of serious and perplexing obstacles.

Microscopic and color tone studies of the reproductions in the reviewer's copy reveal the fact that the conditions under which the plates were etched and the inking and printing were done must have had critical supervision and accurate control. The results, as compared with other scientific illustrations by similar processes, are extraordinarily excellent. The result is that for a modest sum the bird-lover and the libraries of the world may now possess a superb copy of AUDUBON's great work on the birds of America.

The influence of such a publication on the future development of scientific illustration in which color is a factor of technical or perhaps even of psychological importance can not but be significant. The newspaper comic and the movie have already capitalized these values. They afford contrast, emphasis, and quick analysis to the perception of values by the visual route which the scientific writer might well also seek to utilize in his transfer of ideas.

The editor has utilized his opportunity to step on the Dauphin myth of AUDUBON's mysterious origin, to give a critical estimate of the values of this naturalist's scientific work, to direct readers to helpful ornithological literature, and to speak a good word for the much needed conservation of our vanishing bird life. CHARLES A. KOFOID.

Edith Gittings Reid.—*The life and convictions of William Sidney Thayer, Physician.* XII + 243 p., frontispiece portrait. London, New York, Toronto: Oxford University Press, 1936. Price $ 2.50.

This is a biography compiled from THAYER's private diary, from his

letters, and with the aid of his colleagues at Johns Hopkins Medical School, his students, and members of the medical profession which he so highly honored. He was of New England ancestry, from a family distinguished in law, letters, and the teaching profession. His father was professor of law at Harvard, his mother was cousin to RALPH WALDO EMERSON, his brother was Dean of the Harvard Law School, and his grandmother, Mrs. SARAH ALDEN RIPLEY, was distinguished as a self-taught student of the classics. From her he seems to have inherited his linguistic ability, a predilection to science, and a large-minded outlook on life. He read, spoke, and could think in French, German, Italian, and Russian.

He entered Harvard at sixteen, was a " gay dog " for his first three years, after which he was rusticated and completed the senior year under a private master to whom he acknowledged a great debt. Taking the B. A. degree at Harvard in 1885 he entered Harvard Medical School in the autumn of that year. He was known as a fastidious student, but not a poseur, a genial raconteur, with unusual social gifts, with great powers of hero-worship. He responded whole-heartedly to the influence of Professor REGINALD FITZ, his professor of pathology, who inspired in him his latent love of perfection which was so marked a characteristic of his later clinical work. Taking his degree in medicine in 1889 he then spent a year in pathology with VIRCHOW and acquired EHRLICH's blood technique. Shortly after his return to Boston he was called to Johns Hopkins as assistant to OSLER in succession to LAFLEUR. To this institution in which science had a basic place THAYER gave all of that fundamental loyalty which was his outstanding characteristic. He found here a brilliant group, an exhilarating atmosphere, and one not conducive to humility.

It was in this early period that THAYER did his most extensive research work. His knowledge of EHRLICH's blood technique made possible his superbly illustrated *Lectures on Malaria*, 1897. Among the pupils under his stimulus in this early period were JESSE W. LAZEAR, who lost his life studying the method of transmission of yellow fever, R. P. STRONG, now Professor of Tropical Medicine at Harvard, and T. R. BROWN who established the detection of trichinosis in the blood picture. THAYER organized in 1896 the course in Clinical Microscopy which placed the clinical laboratory in medical practice in American medicine. He inspired students to make a systematic physical examination of patients, to record results, to emphasize objective findings, to use caution in regard to subjective interpretations, and to check diagnoses by pathological anatomical examinations at necropsy. He was one of the first internists to insist upon the systematic examinations of the blood, sputum, stomach secretions, and urine. He also stimulated an interest in his students

in the history of medicine and in the consultation of literature on diseases occurring in the hospital and clinics.

His shift in interest from the scientific developments in medicine over to the practice of the art of medicine is revealed in his whimsical essay *The Medical Education of Jones* in which he recognized that medicine was not an exact science and that the exact findings of the laboratory must be interpreted in the light of the fuller study of the patient himself.

In 1897 he represented Johns Hopkins at the XII International Medical Congress at Moscow where he read a paper on *The Increase in Eosinophilic Cells in Trichinosis* and seized upon the opportunity to become familiar with Russian literature.

A Red Cross mission to Russia with its exciting experiences during the Soviet revolution was marred by the tragic loss of his wife in his absence. Service in France as Chief Consultant in the A. E. F., appointment as Professor of Medicine at Johns Hopkins Medical School and Physician-in-Chief of the Hospital crowned a life of usefulness. Three portraits and a bibliography add to the interest of the book.

The author has given a sympathetic and finely drawn picture of the life of one of America's foremost physicians and of a strong and virile character.

CHARLES A. KOFOID.

J. Gordon Hayes.—*The conquest of the North Pole.* Recent Arctic exploration. 317 p., 16 pls., 11 schedules, and 11 maps and diagrams. New York, The MACMILLAN Co., 1934 (first printing). Price $ 4.50.

This is a critical account of Arctic exploration for the last quarter of a century with emphasis on English, Canadian, and Danish explorations, and analysis of geographical discoveries with maps recording the routes of expeditions and discoveries made. The methods and aims of Arctic exploration have changed greatly since the days of Sir JOHN FRANKLIN and ELISHA KENT KANE, with the general result of smaller parties, private enterprise, and much greater emphasis on scientific aspects, hydrographic, meteorological, ethnological, oceanographic, and biological. The areas most assiduously explored have been the forbidding and dangerous East and North Coasts of Greenland, the Canadian Arctic, the North-East Passage, Spitzbergen, and the islands off the Siberian Coast.

The author is skeptical that PEARY ever got nearer than fifty miles of the Pole and renews the scathing criticism of this explorer's accounts which characterized his earlier work, *Robert Edwin Peary*. He is more lenient, however, in his estimate of COOK's claims and character. He states that he probably reached as high a latitude as PEARY and that his "state-

ments, except in relation to his attainment of the North Pole and possibly his Glacial Island, may be accepted as substantially genuine, truthful, and accurate."

STEFANSSON likewise comes in for a persistent castigation for his *Friendly Arctic*, on the ground that his thesis is supported in his own accounts only within 200 miles of land while beyond these limits game animals disappear and the Arctic deserts prevail. He claims that STEFANSSON had no experience of Arctic lands of high latitudes, hence his accounts of the friendliness of the Arctic are true for the Canadian Arctic Archipelago but with serious reservations elsewhere, but credit is given him for inaugurating a new era in polar exploration by his original philosophy of Arctic life, a philosophy which Arctic aviation bids fair to put to the test.

The three Oxford expeditions to Spitzbergen and the Cambridge ones to East Greenland represent the new school of Arctic exploration which avoids publicity, aims at scientific work primarily, and utilizes minimum equipment to accomplish its aims. These receive full appreciation of their enterprise and accomplishments.

The author includes a glossary of technical Arctic terms, a list of Arctic expeditions for 1909-1934, a critical discussion of the limitations of dependence upon game for the support of Arctic exploring parties with adverse judgment as to its dependability and desirability, and a bibliography of 92 recent titles.

It is an illuminating and scholarly treatise marked by a wealth of information and outspoken opinions forcefully stated.

CHARLES A. KOFOID.

Konrad Blersch.—*Wesen und Entstehung des Sexus im Denken der Antike*. Tübinger Beiträge zur Altertumswissenschaft, 29. Heft (1937), 104 pp.

This brochure has a slightly misleading title, as it deals only with the determination of sex in the embryo. It follows the usual outline of the history of Greek philosophy in passing from the Pre-Socratics to ARISTOTLE and Hellenistic science. The chief source for the first two is ARISTOTLE, *de generatione animalium*, though there are also some treatises in the Hippocratean corpus touching on the subject. The theories of the Pre-Socratic natural philosophers followed three main lines : 1. Sex is inherited from one of the parents (ALCMAEON, the atomists, the Cnidian School); 2. Sex is determined by the temperature of the womb (EMPEDOCLES, Hippocratean School); 3. Male and female are connected with right and left, both in the testes and the womb (folklore, ANAXAGORAS). ARISTOTLE's theory is more profound, arising out of a philoso-

phical differentiation of the sexes. For the production of offspring (*τὸ τέλος*) the male furnishes the active idea (*τὸ κινοῦν, τὸ εἶδος*), the female the passive material (*τὸ κινούμενον, ἡ ὕλη*). The sexual organs are the teleological expression of the essential character of the sexes. After ARISTOTLE the most interesting discussion of sex is found in GALEN. Instigated by the anatomical discovery of the ovaries by HEROPHILUS, GALEN proposes a theory that the male and female genital apparatus are analogous, corresponding part for part, but that the male is fully developed while the female represents an arrested stage. The ideas of the Greeks on the determination of sex, as portrayed by BLERSCH, seem remarkably free from empirical and applied knowledge in the form of instructions for predicting or controling sex. Only a few passages of this kind are cited from Hippocratic writings (BLERSCH pp. 30, 39).

We are grateful to the author for this adequate and readable account of an interesting problem in ancient science. The work is critical and documented. The bibliography, however, is too exclusively German.

Indiana University AUBREY DILLER.

George H. T. Kimble.—*Geography in the Middle Ages.* x + 272 p. 20 Plates. London : METHUEN and Co., 1938.

The aims and the limitations of this work have been set forth by the author in his preface :

" While there have been many histories of geographical exploration, the history of geographical thought has still to be written. This volume is offered as a modest contribution to that study. It essays to follow the development of mediaeval earth-knowledge as it was affected, on the one hand, by the prevailing ideologies and, on the other, by the results of human enterprise. Much of the ground covered will be familiar to students, both of history and geography, for my aim has been to select representative men and writings to illustrate the theme rather than to catalogue all the available material, literary and cartographical. Further, few of the conclusions will strike the well-informed reader as novel, but I comfort myself with the knowledge, firstly, that they have not previously been made accessible within the compass of a single volume, and secondly, that the contribution of the Middle Ages to the advancement of geographical studies has still to be adequately appreciated."

Chronologically and topically the ground which Mr. KIMBLE has covered is much the same as that which was surveyed on a larger scale by C. R. BEAZLEY. The author has, however, worked over a large part of the material afresh, and has taken advantage of more recent studies such as those of THORNDIKE, LA RONCIÈRE, J. K. WRIGHT and others. His independent conclusions are confined, largely, to the history of cartography in the 14th and 15th centuries, a field in which he has published several articles during the past five years.

Since the author has to some extent disarmed criticism in his preface, it is unnecessary to insist on inadequacies which the book may present. In my opinion, however, Mr. KIMBLE might profitably have devoted more attention to two problems in the development of medieval cartography which are not without importance for the general history of geographical thought. The first of these problems is to determine the influence exerted on the circular *mappa mundi* of the Middle Ages by surviving Christianized versions of the *Orbis Terrarum* of AGRIPPA. There is a considerable recent literature on this topic (DETLEFSEN, R. DANIEL, UHDEN, A. KLOTZ), and its profound significance for understanding the continuity of the classical and the medieval tradition cannot be overlooked.

The second problem is to ascertain the role of astronomy and mathematics in the development of medieval cartography. It goes without saying that the importance of these two disciplines in the development of scientific map-making has been recognized both in classical and in modern times. It is not so well known, however, that this connection was also recognized in the scholastic period. ROGER BACON, whom Mr. KIMBLE discusses chiefly as a descriptive geographer, constructed a map on the basis of astronomically determined geographical co-ordinates (of Arabic origin, to be sure), and a similar attempt was made in the 14th century by ANDALÒ DA NEGRI. Mr. KIMBLE gives the impression that modern co-ordinate maps inspired by PTOLEMY's *Geographia* appeared only after 1475, (p. 215). Yet the CLAVUS map of Scandinavia and the Vienna-Klosterneuburg maps of Central Europe which I have already described in *Isis* (XIX, 486-502) display evidence that the principles of map-projection were at least partially grasped in the first half of the fifteenth century.

These two problems are, indeed, of a somewhat special character, and it may be debated whether their inadequate treatment constitutes a serious defect in Mr. KIMBLE's book. A more general criticism may be raised, however, which strikes somewhat closer to his basic intention. As we have seen from his preface Mr. KIMBLE has undertaken to present what might be called an essay on the *Kulturgeschichte* of medieval geography. Now in relating the history of his own particular branch of science to the general culture in which it flourished, it is apparent that the specialist is occasionally in danger of finding himself in the position of a mere amateur. This is a danger which must be faced in any work of the type which we are now considering. The lack of an adequate technical equipment in intellectual history becomes particularly apparent in Mr. KIMBLE's attempt to connect the geographical thought of the Age of Discovery with the philosophical and religious background of the 14th

and 15th centuries (pp. 205 ff.). Connections between nominalistic philosophy, mystical theology, nascent humanism and emergent science undoubtedly exist, but they are excessively subtle and obscure. In part they have been traced by modern scholars (JOEL, HEIMSOETH, CASSIRER, DINGLER, DUHEM, MICHALSKI, THORNDIKE and others), yet the field awaits further rigorous scrutiny from specialists. Pending a reliable synthesis, it is perhaps wise to give up the attempt to establish generalizations in these matters, rather than to be forced into invoking such authority as that of Mr. DAMPIER-WHETHAM.

In conclusion I should like to soften the impact of these criticisms by reverting once more to Mr. KIMBLE's prefatory observations. The task which he has set himself was not an easy one. It was eminently worth doing, and within the limitations which he acknowledges, I believe that he has accomplished it successfully.

Harvard University. DANA B. DURAND.

Paul Bergsøe.—*The Gilding Process and the Metallurgy of Copper and Lead among the Pre-Columbian Indians.* København : Danmarks Naturvidenskabelige Samfund, 1938, pp. 5 + 58 (2 Kroner).

The exemplary work of BERGSØE on the metallurgy of the Pre-Columbian Indians of La Tolita and Esmeraldas has already been noticed in these pages (*Isis* 28, 529). In the present work BERGSØE reports the results of his further analyses on additional materials from the same localities. The work is of the first importance, and the author, who possesses a happy gift for saying a great deal clearly in a few words, never ceases to be informative and interesting. He writes with a contagious enthusiasm, with imagination and authority, and his well balanced judgments inspire confidence.

BERGSØE first deals with the copper articles and demonstrates that the metal used was pure native copper and not oxygenous ore. Spectroscopic analysis (the spectrograms are reproduced) shows that the copper used for all the articles came from the same mine. Analysis of a copper disc in the possession of the author from the province of Manabi, Ecuador, strongly indicates that it came from the same source as the Esmeraldas copper. Thus, by spectroscopic and chemical analyses it is now possible to trace native metals to their source, and in this way, as BERGSØE suggests it may be possible to trace the wanderings of metal-using cultures and peoples. Certainly he has placed a new tool in the hands of anthropologists which may prove of considerable value. The people of the Esmeraldas coast were unacquainted with the crucible or furnace, and forged and hammered their native copper into tools; nor did they cast, but melted only, on wood charcoal with the help of a blowpipe, small portions of

copper or gold of about 30 grams in weight. Lead was gathered in natural ingots and treated in the same way. It was converted chiefly into nose rings.

The subject of gilding and silverplating in the Old World and in pre-Roman times is succinctly reviewed, and the method of gilding and silverplating used by the Esmeraldas people is described in detail. Briefly the method consisted in the use of a goldcopper alloy with so low a melting point that it could be made to run over the surface of the charcoal-blowpipe-heated copper, the surplus dripping off. The same method was used in silverplating, but, of course, with the use of silver instead of gold. The use of mercury was, as far as the evidence goes, absolutely unknown.

There are five excellent plates and a list of literature. The translation is again, as in the earlier work, by C. F. REYNOLDS and is very readable.

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

Henry H. Wagner.—*Cartography of the Northwest Coast of America to the Year* 1800. Two volumes in a portfolio. Vol. 1, XII + 270 p., 41 maps. Vol. 2, VI + pp. 271-543. University of California Press: Berkeley, 1937. Price $ 20.00.

The main purpose of this work is to show in one continuous account the evolution of the cartography of the northwest coast of America down to the publication of the accurate maps of VANCOUVER (1798). To this end the author has prepared a critical list of maps, including mainly so-called type maps supplemented by others which provide additional data on place names. His secondary purpose is to provide a list of place names on this coast. His sources have been the original documents either printed or still in manuscript. These include maps in the Huntington and Bancroft libraries in California, and the resources of the New York Public Library, the John Carter Brown Library in Providence, the Ayer Library in Chicago, and the Library of Congress, supplemented by photostats of maps and photographs of globes from various private sources. The nineteen as yet unpublished volumes of the late Mr. P. L. PHILLIPS' *Bibliography of Cartography* in the Library of Congress were especially helpful. These extensive sources have made possible personal inspection which thus insures accuracy of description and completeness of the list of place names.

For convenience the work is divided into two volumes paged continuously. The first contains reproductions of 40 most important maps and a modern map with current place names extending from Bering Strait to Cape Corrientes and the main text of the work. The second contains the annotated list of 39 prediscovery world maps and 862 postdiscovery

ones. This list of maps is annotated with notes on measurements; content; author; place and date of publication (if published); reproductions if seen by the author; copies located, usually one in some library on the western coast, one on the eastern coast of America, and one in some European library; and similarities to and differences from other maps, with respect to the northwest coast only. The maps are listed in chronological order and are indexed by authors' names.

The place names are in two lists, those still in use and those obsolete. Each name has its location, donor, source, synonyms, and the key numbers of the maps on which it has appeared. An annotated bibliography of 17 pages contains specifications, by number in the list, of the maps included in the publication.

The political and commercial motives that supplemented the earlier zeal for exploration emerged when Russian occupation moved down the western coast to the limit of Spanish colonization at San Francisco Bay. From 1774 onward Spain increased her efforts to extend and establish her northern boundaries. COOK's third voyage (1784) and that of the PEROUSE widened European interest in this coast as the importance of its fur trade came to be more evident. The author elaborates the less known Spanish voyages of GALIANO and VALDEZ (1802) published four years after the text of VANCOUVER's voyage appeared. The Spanish maps were issued in a small edition but were adopted by the French cartographers for a number of years. The maps of VANCOUVER on the other hand were used by the British Admiralty and soon came to be well known.

The author comments on the inaccuracies and variations in the determinations of latitude and longitude, especially the latter. By 1800, however, a fair degree of accuracy had been attained.

The author's previous contributions in this field laid the basis for this comprehensive account of the cartography and exploration of a territory which was one of the latest parts of the coastal regions of the Western Hemisphere to be explored and exploited. It was the scene of considerable international conflict among Great Britain, Russia, and Spain, and later between the United States and Great Britain. The geographic structure with its many inlets and islands called for a most unusual amount of geographical exploration. This very natural diversity increased the difficulty of charting and was one of the causes of its delay, its importance, and of the richness of its fisheries and fur trade.

This scholarly historical account of the maps which even more than text record the results of exploration provides a work of reference of lasting value and a tool for the historians of the Northwest. The University printer, Mr. S. T. FARQUHAR, is to be congratulated for this simple but elegant product of the University of California Press. The

reproduction of the old maps, at best a difficult task, has been very well done and the typography of the lists is easily and quickly resolved by the reader's eye.

CHARLES A. KOFOID.

Joseph Jastrow, Editor.—*The story of human error*. XVIII + 445 p., 18 pls. New York: D. APPLETON-Century Co., 1936. Price $ 3.50.

Professor JASTROW with the collaboration of 15 specialists in the various natural and physical sciences has presented a historical summary of the entire scientific realm from the unique standpoint of its many blind alleys instead of its main highways. The surmounting and correction of error has a significant part in the determination of the rate and course of the progress of scientific thinking. The failure to correct error leads to delay and stagnation and " treadmill intellection." The introductory chapter by the editor on the procession of ideas defines the logical framework to which modern science conforms, noting the errors in theory and practice which may occur and those arising from faulty technique. The contrast between the use of intelligence in the scientific laboratory and its all-too limited use in the council chambers of the nations is sharply brought out.

The book falls into two main sections, the world and man, the first being divided into the cosmic, physical, and living realms, and the second into the human and applied ones. In the cosmic realm errors in astronomy cited by H. T. STETSON include the naïve vault of heaven, and the geocentric hypothesis; errors in geology cited by K. F. MATHER include the eternal fire concept of the earth's interior, the Neptunists' idea that all rocks are of sedimentary origin, the wrong interpretations of fossils, the Diluvialists who found proof of the deluge in glacial phenomena, and the nebular hypothesis of the origin of the earth. Errors in geography are found by JOHN LEIGHLY in transfers of ideas derived from known to the unknown parts of the earth, such as habitable zones, the narrow Atlantic, the *Terra Australis Incognita*, and the ice-free interior of Greenland.

The physical realm includes mathematics, physics, and chemistry. E. T. BELL finds the errors of mathematics concealed in their foundations as in the sacred theory of numbers, and its more modern phase that everything is numbers, the synthetic eternal truth concept of mathematics, and the absoluteness of space and time. The errors in physics as reported by F. G. SWANN are the substitution of " common sense " for science especially in seeking in the new too close an analogy with the old, the formulation of scientific hypotheses from general principles instead of with nature as a guide, the search for causes, irrelevance in physical theories, the ether, absolute space and time, the atom, and the tendency

to presuppose that there is only one system of rules in terms of which the phenomena of nature may be correlated. The errors in chemistry are more concretely specified by C. A. BROWNE as the four elements, the four qualities, the errors of deduction by ancient experimenters, alchemy, the three principles, iatrochemistry, phlogiston, the atomic theory, vitalism, and the mechanistic concept of fermentation.

The living realm is discussed only in the fields of zoology, physiology, and neurophysiology, the plant world and bacteriology not being included. H. M. PARSHLEY lists the delusions in zoology as arising from tentative, imaginative, and scientific mistakes, notes the well-known errors of ARISTOTLE and PLINY, mythical animals, and the bestiaries. In more modern zoology he cites the homunculus, EHRENBERG's classic error of visceral organs in the Infusoria, special creation, and the inheritance of acquired characters. H. W. SMITH lists among the errors which have plagued physiology, the blind acceptance of the authority of GALEN, mistaken concepts of the circulation of the blood, the breath of life of PARACELSUS, the *blas* of VAN HELMONT, spontaneous generation, and neo-supernaturalism. C. JUDSON HERRICK notes the speculations of the Greek philosophers on mind-body relations, ARISTOTLE's view that the central nervous system was a cooling mechanism, the spiritual orders of PLATO, the doctrine of temperaments, LA METTRIE's mechanical man, DESCARTES' animal spirits, and the search for elementary units of neural action, especially the reflex (MARSHALL HALL, 1832), conditioned reflexes, and behaviorism. The last three were the apotheosis of an abstraction into a dogma, corrected by SHERRINGTON's (1906) *Integrative Action of the Nervous System*. Another line of error was developed when the accurate mapping of physiological centers in the brain was followed by attempts to localize mental functions. The static recapitulation theories of VON BAER and HAECKEL shifted attention to similarities in the morphology of the brain instead of the more significant differences and thus retarded progress. Psychophysics contained the multiple errors of FECHNER's law, which are " monumentally instructive." The intelligence quotient and other forms of mental measurement are of dubious value and afford little basis for the correlation of mental achievement and neural processes. It is a fallacy of method at the present stage of technique to insist that exact numerical statements are necessarily more accurate than terms of intensive magnitudes. The ancient riddle of mind-body relations still remains a neurological rather than a metaphysical problem.

Part II dealing with man is opened by J. H. ROBINSON's *Procession of Civilization* in which he notes the shift from the search for things to the study of activities and the ancient errors involved in the uncritical and misleading uses of words. Error in anthropology is found by RALPH

LINTON in scriptural dogma, the Nordic myth, early ideas of the age of man, the diffusionist theory, the idea of inevitable unilinear evolution, and the *Kulturkreis* school; G. M. STRATTON finds errors in psychology in the varying concepts of the bodily seat of mental powers, phrenology, the wrong concepts of vision and dreams not excepting FREUD, the reference of differences in intelligence to the air breathed, or to the size or shape of the brain, the idea that the senses give us all the knowledge we have or that knowledge is given to us without our senses or use of inner experiences, the denial of and the undue exaggerations of the subconscious, the handy distortion of the sex factor, and the mere subdivision of mental activity into faculties or into reflexes; H. E. BARNES finds errors in sociology in the myths as to the origin and nature of man and of his social organizations, the social-contract theory, the force theory, social Darwinism, and its opposite the social instinct and other simplifications proposed by the evolutionary school, the golden age of the "state of nature" and natural law, utopias, the theory of progress, geographical determinism, the extremes of revolution and quietism, the biological concept of the social organism, the extremes of social-economic systems as seen in capitalism and Marxism, and premature systematization of social factors; H. W. HAGGARD regards the errors in medicine as due to erroneous basic concepts such as complacency with authority, the supernatural origin of disease, the fallacy of *post hoc*, and the over-emphasis on the physical resulting from the dominant influence of modern experimental methods; ABRAHAM MYERSON notes the older errors of astrology, madness as a punishment, demoniacal possession, and finds in the relatively new science of psychiatry the persistence of the error of separation of mind from body, the diagnosis by coincidence, the subtle persistence of the concept of humours, the separation of physiological and psychological conceptions, and the reliance solely upon the psychotherapy of neuroses, the extension of the hereditary factor beyond proven limits, the polymorphism of the American eugenic school, and the social applications of psychiatry which too often are made to social maladjustments which are not basically psychiatric in origin.

Were it not for the increasing recognition of, and increase in facilities for scientific criticism one might well despair of the future of science in the face of this appalling volume of human error. Even criticism such as this work may still reveal the deflections of personal points of view.

CHARLES A. KOFOID.

Adrian Coates.—*A Basis of Opinion.*—XVII + 461 pag. New York : The MACMILLAN Co., 1938, ($ 4.50).

The charge that philosophy is a futile occupation unbecoming to grown

men; a sort of seeking in a dark room for a black cat which isn't there; a kind of verbal jugglery divorced from meaning and experience, in short, a waste of valuable time, is a relatively modern view. When one considers the amount of energy that has gone into the creation of philosophical systems and into the reading of them—not to mention the resulting mental indigestion,—and how little has accrued to knowledge in consequence of these activities, one cannot but agree that there is some ground for the view. The problems with which philosophy has for the most part been concerned have not been solved through her agency but by science. As J. B. S. HALDANE has said " one of the real signs of human progress is that certain questions are from time to time taken out of the philosophers' hands and settled." Within recent years the successes of science have led to the development of the viewpoint that the only true philosophy is the philosophy of scientific method. It has even been said that there is no philosophy other than science. This is a viewpoint which is associated with the school of Logical Positivism which rejects the older metaphysical philosophies and substitutes instead the philosophy of science or scientific method. It is strange that in such a book as the present which also makes a similar rejection of metaphysics, and which sets out to analyse and define the assumptions underlying the general usage of language, and the meaning of such fundamental and question-begging terms as " reality," " cause, " " existence " and others of a similar nature, that not the slightest reference should be made to the fundamental contributions in these connexions which have been made within recent years by the Logical Positivists. WITTGENSTEIN is, indeed, mentioned, but only in a passing reference. There are many other glaring omissions. Certainly it cannot be conceived a virtue in a book which represents a very original critique of modern philosophical concepts that the author should have omitted all consideration of perhaps the most important movement in philosophy of modern times, that is, Logical Positivism. It is all the more to be regretted because Mr. COATES' book is a good one.

Mr. COATES rejects the obscure and inconclusive discussions of classical philosophy and proceeds to develop an historical anti-metaphysical philosophy which asserts as its fundamental doctrine that Reality is an aspect of History rather than History an aspect of Reality, or that the categories of history are logically more fundamental than the categories of science, and not *vice versa*. Or again, if the problem is posed in terms of Monism and Pluralism, Monism *versus* Pluralism, it is Mr. COATES' argument " that these two contrary attitudes or axioms of thought can only be reconciled in terms of the categories of history. In the context of science and reality we have the single one-way relation of knowing

subject and object of knowledge, and they are bound together in that relation and have no status outside it. But in the actual and historical world we have a society of individuals who are mutually related in terms both of knowledge and will and purpose, each of whom is both agent and knowing subject and transcendental object of other knowing subjects" (p. 394).

From this supremely reasonable relativistic standpoint Mr. COATES pursues his way towards a basis of opinion. Reasonableness he regards as one of the supreme human virtues, and asserts that "reasonableness involves, in the sphere of opinion, unrestricted analysis of all assumptions and beliefs," and this he considers is in essence what philosophy is. He elaborates the point of view that "a philosophy will be valuable in so far as it succeeds in combining a penetrating intellectual criticism with a temper of tolerant humanity." We must abandon the idea that the aim of philosophy is to discover Truth. There is no such Truth to be discovered. It is the aim of philosophy, instead, to arrive at a reasonable Point of View. In this book Mr. COATES brilliantly lays the foundations for such a philosophy of the point of view.

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

Theodosius Dobzhansky.—*Genetics and the origin of species.* XVI + 364 p., 22 figs., 22 tables. New York, Columbia University Press, 1937. Price $3.60.

The *Columbia Biological Series*, noteworthy for its series of scholarly volumes by eminent biologists, such as OSBORN, WILSON, WILEY, LOEB, and CALKINS, was initiated forty years ago by OSBORN's *From the Greeks to Darwin*. After a lapse of a quarter of a century it is now revived under the general editorship of Professor LESLIE C. DUNN of Columbia University, with an able editorial board. The revived series is auspiciously launched in a scholarly volume on a most opportune subject in a dominant biological field by a competent authority.

Professor DOBZHANSKY's *Genetics and the Origin of Species* is a discussion of the mechanisms of the formation of species in terms of the known facts and theories of genetics. This biological discipline has now reached a stage in its development when a general critical survey of its data, especially of gene mutations and chromosomal changes derived both from experimental breeding in the laboratory and garden and from surveys of related genetic stocks of genera, species, and races in nature, is opportune both for workers in the immediate field and for the wider circle of all biologists interested in the various aspects of organic evolution.

Genetics has made rapid strides in recent years due to refinements in

cytological methods and the extension of cytological data such as the analysis of the giant chromosomes of the salivary glands of insects, the extension of information on the prevalence of polyploidy in both plants and animals, and the increasing evidence of the instability of chromosomes. On the other hand, the results of experimental breeding have vastly increased the evidence for the stability of the gene, wherever located, subject apparently only to some evidence of the effect upon it of its position when shifted, its interaction with the cytoplasm of the egg in which it may be acting, and its susceptibility to occasional mutations which may be experimentally induced by X-rays and some other physical agents.

This stability of the gene removes the difficulty which DARWIN faced and vainly tried to meet, namely of the swamping-out effect of blended inheritance of the variations on which he founded his theory of natural selection. Characters in hybrids, such as red and white color, may blend into pink but the respective genes of red and white remain mutually unchanged though in intimate physical contact in the synapsed homologous chromosomes in which they have their fixed location.

Professor DOBZHANSKY's survey covers every important aspect of the relation of the data of genetics to the processes of evolution, including organic diversity, viewed broadly from the facts of speciation in nature to the elegance and precision with which hereditary types may be synthesized at will by the breeder having stock of known genetic constitution in hand; gene mutations as observed appearing spontaneously or induced in laboratory stocks, or detected in nature; mutation as a basis for racial and specific differences; chromosomal changes resulting from hybridization or other natural or experimental conditions; variation in natural populations interpreted in the light of results in controlled populations and laboratory results; natural selection as operative on the genetic materials derived from gene mutations and chromosomal changes; polyploidy, in which the haploid chromosomal sets are reduplicated in the cell with resulting increase in size and vigor of the individual or in other characteristics; isolating mechanisms of environmental or physiological origin and their effect on the status of the breeding stock; hybrid sterility resulting from lethal combinations and chromosomal maladjustments; and species as natural units due to a fundamental discontinuity in the gametic make-up of organisms.

The science of genetics has been in a state of flux out of which a more or less permanent terminology has been emerging but in which uniformity of usage of terms and of their distinctive meanings is far from being established. The author should add a glossary in the next edition to assist the reader and the makers of future dictionaries. A bibliography

of 28 pages affords a faint concept of the magnitude of the literature in this field.

This analytical survey of the evolutionary implications of the data of genetics tends to verify the basic significance of the gene, of gene mutations and chromosomal changes, of natural selection as an effective sifting process in the extermination and conservation of individuals offered by genetic combinations, of the importance of isolation in the establishment and maintenance of species and races in nature, and of the reality of species and their natural classification.

The work is exceptional in its completeness, balance, clarity, and logical presentation of a complicated, diversified, rapidly developing, and important field of biology destined to hold a significant place in the history of organic evolution.

CHARLES A. KOFOID.

Berthold Laufer (1874-1934).—*The American Plant Migration*: 1. *The Potato*. (Prepared for publication by C. MARTIN WILBUR). Portrait of Author, 132 p. Field Museum of Natural History, Anthropological Series 28 : 1-132 (Publication 418), Chicago, 1938.

The late Dr. LAUFER left several unfinished manuscripts and thousands of miscellaneous notes. Probably most of this material can never be published but some seven or eight manuscripts dealing with cultivated plants were so nearly completed that it may be relatively easy to prepare them for the press. Fortunately, Mr. C. MARTIN WILBUR has set himself the task of bringing order out of Dr. LAUFER's unfinished work, and we are indebted to him for this contribution.

Dr. LAUFER had published a preliminary article on American plant migrations in 1929 (*Scientific Monthly* 28 : 239-251). Apparently he had intended to write a series of monographs each dealing with the wanderings and vicissitudes of a particular plant. If this first part of his work is a true sample of the whole, there is little doubt but that the work as planned would have set a new standard in its field.

The spreading of the cultivated American plants over the rest of the world was by no means a simple process. The potato (*Solanum tuberosum*), for example, which was originally cultivated in Peru, reached Virginia in 1621 from Bermuda. It had been carried to Bermuda from England in 1613, and England had received it c. 1586 from either the West Indies or the northern coast of South America. While the Spaniards carried the potato to the Philippines at a very early date, it is only a recent immigrant in China where it is still looked down upon as a poor man's food. On the other hand the sweet potato (*Ipomoea batata*) is highly esteemed in China while it is still scorned in Europe. Perhaps, if we knew more

about the factors involved in the migration of cultivated plants we might discover some clue as to why even the most civilized peoples are content with diets which any botanist knows are needlessly monotonous.

An evaluation of Dr. LAUFER's work must of course await the publication of the remaining parts. Part 1 is most carefully organized and thoroughly documented (a bibliography of approximately 275 titles). It is more detailed and accurate than any other account which we have of a plant's migration.

CONWAY ZIRKLE.

Carl J. Warden.—*The emergence of human culture.* VI + 189 p., 10 pls. The MACMILLAN Co., New York, 1936. Price $2.00.

The author distinguishes the biosocial level of evolution as the first step above the non-social in the animal world. The former pattern becomes fixed in the germ plasm and is extremely difficult to change. This latter thesis is questionable in the light of the extraordinary diversity of biosocial patterns as exhibited in commensal associations throughout invertebrates and the even greater diversities of social pattern within a species of the same genus of termites, ants, bees, and wasps. The indeterminable relation of geologic time may, however, be cited in defense of the statement. These patterns have advanced far beyond the rather loose, but rather more adaptable biosocial patterns of the anthropoids, man's nearest living relatives.

The emergence of the human cultural order marks the greatest cultural advance yet attained since it releases the expansion of social patterning from the bondage of genetic evolution. This thesis is only partly defensible since hereditary factors of inventiveness, imitativeness, and educability enter in varying degrees into the evolution of the various patterns of human culture. The tempo of social evolution is, however, subject to the accelerations arising from the human control of communication, technical skills, and all social habituations such as education. These lead to higher orders of integration and facilitate greater rapidity and diversity of changes in the social life of man.

The author concludes from an analysis of societal patterns among insects, birds, and mammals that none of them rise above the level of the biosocial. They are genetic in origin, resting upon the hereditary mechanism. Practice and imitation afford at this level a modicum of individual social facilitation but there is no evidence of tradition. Invention, communication, and social habituation is lacking in them all.

The evolution of human culture is based on the organic evolution of brain, hand, posture, and lengthening of the period of sexual immaturity. These make possible sound cultural advance, invention, communica-

tion, and social habituation of the young. This cultural realm is as autonomous as the inorganic and organic and has its own societal mechanisms.

The author traces the progress of human culture through its successive stages and defends the concept of the universal culture pattern by distinguishing a primary cultural phase of a generalized character rising above the biosocial level. Upon this universal pattern secondary diversifications arose in the course of human social evolution.

The author finds no support for the dogma of continued social progress. The need for social guidance increases with every added acquisition of social power. The descent to the social Avernus is easier than the long and laborious ascent. C. A. KOFOID.

Franz Boas.—*The Mind of Primitive Man.* XI + 285 p. New York : The MACMILLAN Co., 1938, ($ 2.75).

The Mind of Primitive Man was first published in 1911; the present volume is described as a revised edition of that work; in reality the revision has been so extensive that the present edition must be regarded as a new book. Without a doubt the present work represents the best presentation of the conclusions of anthropology that exists in any language. In his eighty-first year of life and in his sixtieth year as an anthropologist this very great book exhibits the mind of BOAS in all its crystal clarity, and shows his spirit to be as well-balanced, as humane and as courageous as ever.

Here between the covers of this book will be found the distilled essence of the best and most reliable findings of modern anthropology on the nature and meaning of race and culture, after they have been passed through the alembic of the first-rate scientific mind of the world's foremost anthropologist. A substantial proportion of the fundamental and most important researches in these fields were undertaken and completed by BOAS himself, so that he writes with authority, understanding, and clarity on subjects which are by no means always well understood by many anthropologists. In this book BOAS stresses the fundamental unity of mankind, and the capacity of all peoples " to reach the level of civilization represented by the bulk of our own people "; and he shows that " the overwhelming importance of outer, cultural conditions is... so great, and the quantitative racial differences between large populations are so slight in comparison that none of the claims for substantial differences between races seem to be scientifically sound " (p. 144).

" Freedom of judgment can be attained only when we learn to estimate an individual according to his own ability and character. Then we shall find, if we were to select the best of mankind, that all races and all nationa-

lities would be represented. Then we shall treasure and cultivate the variety of forms that human thought and activity has taken, and abhor, as leading to complete stagnation, all attempts to impress one pattern of thought upon whole nations or even upon the whole world."

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

H. V. Routh.—*Towards the Twentieth Century.* x + 392 p. New York: The MACMILLAN Co.; Cambridge: At the University Press, 1937, ($ 3.50).

We of the Twentieth Century have lost our religion. In emptying the Nineteenth Century tub of its murky elements we have thrown out something which, confused and chaotic as it was, was valuable, a spiritual quality which this Age completely lacks; this, the Age of Science, of the Machine, of Cynicism, and Disillusion; the Age which has seen the most cherished virtues of humanity ruthlessly trodden underfoot by the new barbarians of Fascism; the Age, in short, in which we live. Towards an understanding of this remarkable period in which most of us pursue the uneven tenor of our way Professor ROUTH has written these essays in the spiritual history of the Nineteenth Century, in the hope, as he says, of finding an explanation of the present in the spiritual history of the immediate past.

Professor ROUTH, who writes chiefly of England and Englishmen, inspires confidence from the very first page of this delightful and important book. If we are to make the inquiry into ourselves by the test of our predecessors, it is at the outset desirable that an efficient approach or method be settled upon. Generalizations,—streams of tendency, periods of transition, spirit of the age—cannot explain the great authors of the last century. "The true sign of the times was spiritual isolation, not intellectual fellowship. Despite appearances, culture had become a personal problem, intimate and fundamental, both for the writer and the reader, on both sides obscured by touches of disingenuousness. So it was necessary to concentrate on individualities, the most prominent because the most representative. At the same time, it was necessary to penetrate deep below the surface in order to discover what their thoughts really meant to them and should mean to us."

In Professor ROUTH's hands this approach has proved singularly fruitful, and what he set out to do he has ably achieved. The Nineteenth Century, Professor ROUTH points out, was a century over-civilized and under-cultured—civilization being understood as the whole complex of the relation of man to man, and culture as his sense of his relation to the meaning of himself and of life. It was the failure of the Nineteenth Century

authors that they never wholly succeeded in reconciling culture to civilization, and that even more so, we may add, is the failure of the Twentieth Century. Whereas the writers of the preceding century set out to explore new country with an old map, taking for their compass the idea of God, we of the present century have devoted all our attention to the making of new maps for the exploration of ever new country and for our compass we have created something that we call scientific humanism, but in our anxiety to make ourselves masters of all Nature we have forgotten what the Nineteenth Century never failed to remember—the civilization and the culture which they hoped and failed to reconcile. Hence the spectacle of the uncultured educated man or scientist of our own time who is utterly indifferent to aught else but his own narrow occupation, and for whom civilization means, if it means anything, the amenities which the physical sciences have brought us. Is it any wonder that with such an attitude of mind—and culture is essentially that—civilization should be going the way it is? When men lose their religion, or when their religion becomes anthropocentric, their culture becomes an introverted one, and they lose touch with the strivings and the interests of their fellow men. This actually is what the Nineteenth Century achieved for the Twentieth Century, and the significant fact is that it was Science alone and single handed that achieved this spiritual breakdown. The evolution was a peculiar one, and in this book Professor ROUTH brilliantly analyses its development from the early Nineteenth Century belief in a creative Intelligence which reached its consummation in the human mind, through the religion of the intellectualism of JOHN SUART MILL, to the post-Darwinian rigorism of Science, " the world of humanistic insight and scientific imagination, which poets, moralists, and novel writers also must capture." It is with these words that Professor ROUTH closes his noteworthy book. Let us hope that the note of optimism which they sound for the spiritual development of the Twentieth Century shall not prove to have been in vain.

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

Lancelot Hogben (Editor).—*Political Arithmetic : a symposium of population studies.* Pp. 531. New York, The MACMILLAN Company, 1938. ($ 9.00).

This noteworthy symposium signalizes the coming-of-age of political arithmetic, now rounding out its third century of growth. It is a credit to the Department of Social Biology of the University of London where the researches here reported were conducted. It is difficult to choose among

the twelve chapters in point of excellence. Each represents a notable contribution to its particular field.

In a typically vigorous introduction, Professor HOGBEN announces his intolerance of economic mysticism and scarcity dialectics and presents a case for factual social studies rather than home-spun verbalistics. Dr. KUCZYNSKI's essay in which he has combed the available materials to find " British demographers' opinions on fertility, 1660 to 1760," will prove of particular interest to the readers of *Isis*. The demographic observations and inferences of GRAUNT, PETTY, D'AVENANT, HALLEY and GREGORY KING, as well as their less widely known successors of the eighteenth century, are systematically summarized.

Part I contains six papers which document with high fidelity and skill KUCZYNSKI's basic conclusion : " No conceivable decrease of mortality or increase of nuptiality will have a decisive effect upon the future net reproduction in the total territory comprised by Western civilization. The decisive factor will be the trend of matrimonial fertility." (72) Dr. ENID CHARLES demonstrates this with statistical acumen and realistic inferences in the case of Great Britain. D. V. GLASS shows that although one can establish a relationship between fertility and such social factors as the marriage-rate, employment of women and occupational distribution *at any given time* in England and Wales (from 1851 to 1931), yet changes in these concomitant factors have not been responsible for the noticeable decline in fertility of the last six decades. This decline is due to factors common to all parts of the country and to all types of occupations.

Part II, which deals with the " recruitment of social personnel," contains two remarkable essays by Professor J. L. GRAY and Dr. PEARL MOSHINSKY, which should be called to the attention of every educational administrator. This essay is the most meticulous and convincing analysis of the relations between children's ability and educational opportunities known to the reviewer. Through the careful study of more than 10,000 London school children, they conclude that " on the highest criterion of ability 45 per cent... of the total number of gifted children in the school population do not enjoy the opportunity of a higher education." Moreover, and this fact is even more striking, although only 3 % of " free pupils " in secondary schools fall below a selected (high) level of ability, nearly 50 % of fee-paying pupils (from families of substantial economic means) fall below this level. It was found that " on their observed performances alone the comparatively poor very greatly preponderate in the production of individuals of high ability." This demonstration of a maladjustment between ability and opportunity for higher education emphasizes the need for a series of similar studies elsewhere and, guided by the findings, a revision of the system of selecting candidates for further education.

The present trial-and-error arrangement which is dictated by our peculiar economic structure is patently in need of serious revision. It might be suggested that such inefficiency, as that involved in our machinery of social selection, would not be tolerated by the technological engineer. Studies such as these exemplary ones now provide the basis for the social engineer who is no longer content with the plea of sociological ignorance. In the past the issue has been beclouded by pointing out that a larger *percentage* of the economically well-to-do classes have a high level of mental ability. This has almost invariably been found to be the case. But, as these writers demonstrate, a much larger *number* of gifted children derive from the economically less advantaged classes. In deciding upon social policy, it is obviously absolute numbers and not percentages which in this instance constitute the primary consideration.

A final essay on the distribution of the blood-groups and its bearing on the concept of race sheds needed light on a much discussed and little illuminated problem. Inasmuch as the iso-agglutination blood-groups involve the only type of ethnic differences concerning the genetic mechanism of which we possess definite information, a comparison of their distribution with that of anthropometric criteria is highly valuable. ALLISON DAVIS finds virtually no correlation between the distribution of blood-groups and that of such commonly employed criteria of race as hair-form, skin-colour, nasal index, stature and cephalic index. On these and similar grounds, he suggests that the vast majority of mankind is not divisible into natural races at all.

The researches described in this volume bear ample testimony to the value of investigations oriented toward specific problems.

Harvard University. ROBERT K. MERTON.

Lewis Mumford.—*The Culture of Cities.* VII + 586 p. New York : HARCOURT, BRACE & Co., 1938, ($ 5.00).

In this work, a continuation of the author's *Technics and Civilization* (New York, 1934; *Isis* 22, 548-51), Mr. MUMFORD takes a particular and far-reachingly important aspect of reality, the city, and analyses its growth and development, and its effects upon man. The relations here, as always, are reciprocal : Man creates his environment and the environment which he has created in turn creates him. One of the most distressing symptoms which may be observed in so many men of our time is the complacency with which they accept an environment which represents the apogee of all that is ugly and brutalizing; the seeming indifference with which they will submit to sights and sounds and odours, to conditions of living, which are so monstrous that they have to be experienced to be believed. The city is invulnerable to the frightfulnesses which it creates, but man

is not; and in order to exist in it he must adapt himself to the exacerbations which it puts upon his spirit. In proportion as he makes the adaptation his sensibilities decline and atrophy. In closing his eyes to so much, in so much does he become caliginous; the patina which he acquires by living in cities is an *urbanitas* without *humanitas*, in short, in the cities the dehumanization of man is virtually complete. The factors operative here may simplistically be envisaged in terms of cause and effect. As cause there is the wanton capitalistic exploitation of man and nature, and as effect the degradation of man and the defilement of nature. Mr. MUMFORD traces the process with clarity and effect. From the mediaeval town with its encircling wall dominated by cathedral and market square, to the rise of the national states with their capital cities dominated by army and bureaucracy, to the " Coketown " of the industrial revolution built for machines rather than men, to Megalopolis, the modern giant city, the prestige symbol of monopoly capitalism and credit finance, over-civilized and under-cultured, the simple pattern of this cause and effect relationship has held increasingly and more unfortunately true.

After tracing the stages of the cycle of growth and decay of the city the author adumbrates the nature of the city towards which he hopes we may yet move, wherein a new biological and social environment will flourish in which the highest possibilities of human existence will be realised. The one hundred and forty excellent illustrations assist both his history and his discussion of what is immediately possible in the planning of the new city. There is an annotated bibliography and a good index.

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

G. G. Coulton.—*Inquisition and Liberty*. XIII + 354. New York : The MACMILLAN Co., 1938, ($ 4.50).

The presence of Dr. COULTON's name on the title-page of a book is sufficient guarantee that the book will be scholarly, reliable, humane, and a delight to read. The present volume is no exception to that rule. It is characteristic of the author's thoroughness that the book, in which there occurs not a single error of any kind, textual or typographic, should be prefaced with an apology that it was " necessary to go to press without his last personal revisions " before starting for South Africa. It is to be hoped that Dr. COULTON's literary and scientific conscience have now been set at rest, and that his journey to South Africa was unimpeded by the thought of a possible misplaced comma.

In this book Dr. COULTON has devoted himself to a very timely telling of the workings of the Inquisition in Europe, writing not from the secure mountain-height of a dispassionate narrator telling of a far-off time,

but from below, at the level of the participants themselves. In this way, assisted by many well chosen quotations from such participants, the reader is able to visualise something of the situation in which he would find himself were anything of the kind again introduced into his own life. The barbarism of the Totalitarian States of our own day; the persecution of Protestant, Catholic, Jew, and Socialist; the fact that in rebel Spain it is enough to hold a Trade Union card to merit sudden death, all these contemporary ghastlinesses are ominous reminders of the days in the Middle Ages when the informer was an integral part of the State machine, and the holder of an unorthodox view, however noble, was guilty of high treason against the God of an Inquisitor's imagination and a Pope's decree.

Dr. COULTON's book, written in the fairest spirit of the humanist, is one of the most damning accounts of the Catholic Inquisition, and incidentally of the Church itself as well as its temporal representatives, that has appeared within recent years. Yet the condemnatory evidence is almost entirely drawn from Catholic sources. In his endeavour to be as sympathetic as possible Dr. COULTON strives to make out a case for the Inquisitors and their associates, but he is unable to find a more cogent basis upon which to rest his case than the doubtful argument that had we been in their place we would probably have behaved no better. This may well be so, but there is a danger in thinking thus of missing the point that we might equally as well have been among the heretics. It is true that the Middle Ages were culturally a different kettle of fish from the Twentieth Century, nevertheless it is well to remember that the Middle Ages had its noble men, its pure thinkers, and its doubters, as this book witnesses, and that while it was then unquestionably more difficult for the ordinary man to win through to intellectual independence than it is to-day, still many did so, and neither the threat and the practice of untold torture nor the horror of the stake caused them to turn back on the way they had travelled. It is well to remember that the Inquisitorial attitude of mind still exists as the Catholic Church and that the Inquisition itself is still maintained under the name of the Holy Office, and that both institutions are far from dead. The Catholic Church was never so weak as it is to-day, and from year to year it grows steadily weaker. Is this because of an inherent weakness in its structure, or is it because of the advance of free thought? I think there can be no question but that the decline is due to an inherent weakness in Catholicism itself, and moreover that it is due to this very weakness that free thought has in Europe advanced as much as it has. Catholicism is a religion which challenges thought. Faith it commands. But without the means to enforce its commands a Church is in a precarious position, especially

when that Church happens to be one whose doctrines are so stimulating to doubt as the Catholic. One has but to take thought upon any of its doctrines to become at once an heretic. Force eliminates heretics as well as thought, and at the same time possesses the property of being able to enforce whatever kinds of belief may be required—those who refuse to yield are simply suppressed.

The point it is desirable to recognize is that it is not so much that the cultural conditions of the Middle Ages inspired men to behave in a certain manner because they were culturally naturalized to do so, but that a vast majority behaved so because they were forced and terrorized into doing so by the Holy Arm of the Church, in much the same manner as the Nazis and the Fascists force millions of people into their own camps to-day. The important point, however, which Dr. COULTON seems to me to overlook is that the Nazi and Fascist Inquisitors of to-day belong to the same species of barbarian as the Inquisitors of the Middle Ages. We live in the Age of such barbarians, yet we are not of them. Is it not a fallacy to reason as Dr. COULTON has done in slight extenuation of the older Inquisitors to say that had we been in their place we might have done no better? We have every opportunity of being in their place, under much the same conditions, yet we do not advantage ourselves of the fiendish opportunity. No, the attempt to extenuate, though it be ever so little, the unutterable cruelties of the Inquisition does Dr. COULTON honour, but in no way alters the case against the Catholic Church. Dr. COULTON with the impartiality of the true humanist presents the case at the bar of humanity; he knows what the verdict has already been and what it will continue to be, and he is in agreement with it. It is the most terrible indictment that has ever been launched against any human institution.

Everyone will agree with Dr. COULTON's conclusion, "In ninety-nine cases out of a hundred, the experience of later generations suggests that it would have been wiser in the Church to have made no appeal to force, but only to argument and good example. Even in the hundredth case, and even when we have made all allowance for the circumstances of the time, the peculiar methods of the Inquisition were indefensible."

Hahnemann Medical College, Philadelphia. M. F. ASHLEY-MONTAGU.

Juan Ramón Beltrán.—*Historia del Protomedicato de Buenos Aires* (Buenos Aires, 1937).

The Spanish *protomedicato* was a college or commission of physicians, appointed by the king, the duties of which were to examine and licence all practitioners, and to legislate in all matters concerning the public health. It was established in the fifteenth century by JOHN II OF CASTILE

and functioned as the supreme tribunal of medical practice until its suppression in 1822. *Protomedicatos* were set up in the universities of Mexico and Lima, by the law of January 11, 1570, with the same procedure as that of Castile. But it was not until the establishment of the Viceroyalty of Buenos Aires in 1776 that a *protomedicato* was set up there. Hence, it seems to this reviewer that it was a mistake to fill a volume with the history of the latter, when the *protomedicato* of Lima functioned in the same territory for the preceding two hundred years. The thirty-odd pages of introductory matter devoted to antecedents are entirely inadequate.

The fault, I suspect, lies in Sr. BELTRÁN's method. He has chosen the easier way of consulting laws and decrees, rather than the documentation necessary for a picture of the functioning of the system. (It may be, of course, that there is no such documentation available.) The result is that the reader, who is unacquainted with the ways of Spanish colonial administrators, gets the notion that the institution functioned more or less as the law disposed. Such, of course, was hardly ever the case. Rather, the administration of all Spanish colonial institutions (and some of ours, I suspect) depended upon the greater or smaller amount of zeal and integrity of the local officials. Sr. BELTRÁN's work, while it may have some value for those who are interested in the purely juridical aspect of the history of medicine, offers little that contributes to the history of medical practice.

University of California, Berkeley. LESLEY BYRD SIMPSON.

Geschichte der Gesellschaft der Aerzte in Wien 1837-1937 herausgegeben von der Gesellschaft der Aerzte; mit 14 Abbildungen im Text. Wien, Verlag von JULIUS SPRINGER, 1938. Price : paper cover RM 18; cloth RM 21.

From May 19th until May 29th 1937 the " aerztliche Festwochen " were celebrated in Vienna on the occasion of the centennial of the Gesellschaft der Aerzte in Wien. One remembers the corresponding articles and proceedings as published in the *Wiener klinische* and *Wiener medizinische Wochenschrift*, and EPPINGER's great monograph : Die Leberkrankheiten, dedicated to the society on this occasion. Now appears this work : Geschichte der Gesellschaft der Aerzte in Wien of 299 pages, edited by the society itself, the writer I. FISCHER modestly hiding his name.

The book is divided into ten chapters. Chapter I-V contain the history of the society, chapter VI a short review of the history of its library, chapter VII a review of the journals which have appeared under the

patronage and supervision of the society, chapter VIII the endowments of the society, chapter IX various tables enumerating the officers, the number of annual meetings, papers, books, the annual earnings, expenditures and fees of the society during its existence; chapter X contains the names of the 1799 authors mentioned in the previous chapters who have spoken at the meetings of the society. Besides page references o these authors, their birth- and death date is given and, in case of those occupying an academic position, there is an outline of their career after their " habilitation ".

Of the five historical chapters the first deals with the birth history and foundation of the society; the second with the period between 1830 and 1850; the period before ROKITANSKY became president; the third with the period 1850-78 when ROKITANSKY was again and again reelected as president; the fourth with the period from ROKITANSKY's death until the beginning of the war; and the last with the war- and post-war period. These chapters are subdivided into three sections : administration (changes of by-laws and amendments), external activities (such as legal suggestions and public appeals), and scientific activities. The scientific activities are organized for each period according to the usual classification of diseases and departments of medicine. In each is given the title of the paper concerned, the name of the author, and the date of presentation.

Especially interesting from a general point of view are the first chapter and the first section of the second chapter. These reflect the political difficulties and supervision which even medical societies had to face in the time of the " Vormaerz," as for instance : the troublesome procedure involved in the election of foreign members or the tone of the answer of the police department regarding the opening of the reading room to non-members (" considering the previous blameless behaviour of the society)."

It would be invidious to call particular attention to any of the papers mentioned under the scientific activities. The names of such members as ROKITANSKY, HEBRA, SKODA, BILLROTH, WAGNER-JAUREGG, EISELBERG speak for themselves.

The book is smoothly written and owing to the authors' index it is an excellent reference work to the exact date of publication of many important medical contributions of the last century.

San Francisco, Calif. OTTO E. GUTTENTAG.

Administrative Papers

Richmond meeting of the American Association for the Advancement of Science (last days of 1938).—*Section (L) Historical and Philological Sciences.*

The Richmond meetings of Section L were among the most important it has ever held. They centered primarily upon a symposium covering the Cell Theory—its development, its present status, and its future possibilities,—and combined the best thought of the three sections (L, F, and G) that collaborated in the organization of the meetings. Seven outstanding papers by eminent scholars (and an eighth which was read by title only, because of lack of time) were presented in the two sessions. The discussion and attendance throughout were exceptionally good, over 150 being present at the afternoon meeting. Appropriate slides were used by several of the speakers.

The morning session, which was devoted to historical aspects, brought some surprising results, especially as bearing upon the two men, SCHLEIDEN and SCHWANN, who until the present day have been given most credit with respect to the origin of the cell theory, and whose contributions appeared a century ago. There was apparent unanimity of opinion in the scholarly papers presented by Professors WOODRUFF, KARLING, and CONKLIN, that the cell theory was projected sometime prior to the appearance of the works of SCHLEIDEN and SCHWANN, that these two men added nothing either in content or in clarity with respect to the theory as such, and that they in fact lent support to a general view of cell formation which was completely erroneous. One hundred and seventy years earlier, Sir ROBERT HOOKE had described little boxes or cells seen under a simple microscope, and from his day onward other significant observations on cells had been recorded by such men as MALPIGHI, GREW, WOLFF, LAMARCK, and others. With the beginning of the 19th century, the cell theory came into sharper focus and received fairly clear and explicit delineation by MIRBEL (1802 to 1809), DUTROCHET (1824), TURPIN (1826), MEYEN (1828 to 1838), BROWN (1831), DUMORTIER (1832), PURKINJE (1835), MOHL (1835 to 1839), and VALENTIN (1838). All these significant contributions preceded the works

of SCHLEIDEN and SCHWANN. Why then, it was asked, have these two men been called the founders of the cell theory? Why the amazing situation " that we still continue to call it after them "? It would seem, as suggested by two of the participants in the symposium, that bluff and brag on SCLHEIDEN's part entered very largely into the picture. He underestimated, ignored, or ridiculed really important contributions of predecessors and contemporaries and thus gained a wholly unwarranted recognition. And SCHWANN borrowed from SCHLEIDEN's arrogant claims as to plant cells and applied the same views to animal cells. Professor CONKLIN concluded his most interesting paper by suggesting that " it would be more accurate as well as more becoming to strike out of our literature these personal possession tags attached to important discoveries, such as... the cell theory of SCHLEIDEN and SCHWANN."

The afternoon session of the Symposium, devoted to the present and the future of the cell theory, developed an interesting cleavage in points of view between those who appear to see the problem primarily in terms of physical forces (of surface tensions, pressures, and electrical attractions and repulsions) and those who hold that living matter exhibits certain characteristics (such as variability, selective direction, and unfoldment in a temporal sequence) which sharply differentiate the organic from the inorganic. It was generally agreed that the organization of the cell is exceedingly complex and that there is still much to be learned about it. Yet, on the one hand, it was maintained by Professors BAITSELL and SCHRADER that the difference between the organic and the inorganic is " not one of *kind* but merely of *degree of complexity*," and that a " dynamic hypothesis " seems the most reasonable in explaining the complicated behavior of the cell nucleus. And, on the other hand, it was pointed out by Professors WEISS and MCCLUNG that, although " the cells derived from an egg have definite, innate capacities of their own, the fact that the individual cell can differentiate in a variety of directions but actually differentiates only in one, calls for factors which direct each cell selectively into its proper course. These factors, by their very nature, are super-cellular." They apparently derive from the organism as a whole and suggest the presence of " racial material in a linear order within the chromosomes... Since living systems have unique phenomena of a higher order (than the non-living), like reproduction, metabolism, and consciousness, it is only logical to conclude that there must be units of a new order to explain them." It rests with the future, it was held, to effect a reconciliation between such points of view.

(*Library of Congress.*) JOSEPH MAYER.

History of Science Society.—Program of the Chicago meeting in association with the American Historical Association (December 29-30, 1938). Headquarters, Palmer House, Chicago.

Thursday, December 29

10:00 A.M.—Hotel Stevens. North Assembly Room.
Chairman, RICHARD H. SHRYOCK, University of Pennsylvania.
ARNO B. LUCKHARDT, University of Chicago :
" Dr. WILLIAM BEAUMONT and the recently acquired BEAUMONT memorabilia of the University of Chicago."
K. K. CHEN, Lilly Research Laboratories :
" Caapi of the South American Indians."
DANA B. DURAND, Harvard University :
" Science and philosophy in late scholasticism."
GEORGE DE SANTILLANA, Harvard University :
" The emergence of scientific concepts in history—MACHIAVELLI."
GEORGE SARTON, Carnegie Institution :
" COMENIUS and BAYLE."
12:30 P.M.—Hotel Stevens. Private dining room no. 10.
Luncheon-conference for Council of History of Science Society.
3:00 P.M.—Museum of Science and Industry.
57th Street and Lake Michigan, Jackson Park.
Meeting, lecture, and exhibition.
5:00 P.M.—Visit of BEAUMONT exhibition, Billings Hospital, University of Chicago (courtesy of Dr. LUCKHARDT).
7:00 P.M.—Palmer House. Room no. 17.
History of Science Society Dinner.
The Council met after dinner.

Friday, December 30

10:00 A.M.—Hotel Stevens. Room 440A.
Morning round table of the American Historical Association.
Chairman, GEORGE SARTON, Harvard University :
" Technology in the Middle Ages."
LYNN WHITE, Stanford University.
Discussion leader, HENRY E. SIGERIST, Johns Hopkins University.
2:30 P.M.—Hotel Stevens. West Ball Room.
Joint session of the American Historical Association and the History of Science Society.
Chairman, CHAUNCEY D. LEAKE, University of California :
" History, Science and Society."

FREDERICK BARRY, Columbia University.
WILLIAM E. LINGELBACH, University of Pennsylvania.
HENRY E. SIGERIST, Johns Hopkins University.

7:00 P.M.—Hotel Stevens. West Ball Room.

Joint Dinner of Middle West Branch of the American Oriental Society and the History of Science Society.

Speaker, GEORGE SARTON, Harvard University :

" Oriental Science."

History of Science Society

REPORT OF THE SECRETARY-TREASURER

The office of the secretary-treasurer of the History of Science Society was taken over from the previous incumbent February 15th, 1938 and the following report covers the period from that date to December 1st, 1938, the end of the fiscal year for the Society.

Secretary

The files of membership in the Society have been completely revised, yet even at the present date the secretary is not sure that he knows all of the members of the Society. It is only after next year's bills go out that this can finally be checked. Great help in this matter, however, was obtained through the cooperation of Dr. Sarton, who sent out with one of the numbers of *Isis* for this year a leaflet requesting members of the Society to send to me their correct name and address, as well as the date on which their last dues were paid. Replies were received from a large number of the active members. On December 1st, 1938 membership in the Society is as follows :

Resigned during the year 1938	10
Died during the year 1938	4
Total loss in membership	14
New members during 1938	44
Net gain in membership	30
Active members	445
Active library members	142
Total membership, Dec. 1, 1938	587

The records of members are now reasonably complete and on proper cards so that the office work can be easily handled. Through the courtesy of the Boston Medical Library an office was granted to us for permanent use, without charge.

The question of approval of manuscripts for publication should be brought before the Council. Manuscripts are still being referred by the American Council of Learned Societies to the secretary for examination. At present there is no method of handling this material. There should be a board appointed with sufficient authority to pass upon manuscripts submitted so that a prompt reply may be sent to the American Council of Learned Societies. It is still to be hoped, moreover, that any royalties accruing from such publications will revert to the History of Science Society.

The method of approval of members recommended for the Society appears to the secretary to be somewhat cumbersome. It is hoped that a more simple arrangement can be devised. At present a rather elaborate invitation is sent out under the name of the president. If application is made as the result of this invitation, approval must be obtained from the president of the Society as well as another member. This entails a good deal of correspondence. The fact that certain applicants would appear to the secretary to be welcome as members, without question, leads to the suggestion that the secretary might be allowed to accept these applications without further confirmation. It seems likely, moreover, that either the president or Dr. SARTON could be easily reached in case of any doubt in the secretary's mind.

TREASURER

Of the 445 active members, 25 still had not paid their dues for 1938 at the end of the fiscal year. In one or two instances dues had not been paid for two years. As has been pointed out in the previous treasurer's reports, it seems likely, however, that a considerable number of these dues will be paid during the coming year. It is possible, moreover, that some of these dues have been paid in the past directly to the Brussels office and therefore there has been some confusion in keeping the records. This practice is to be discontinued and all accounts in regard to the History of Science Society will be handled in the treasurer's office. Of the 142 library members, 13 remain unpaid for 1938 at the end of the year. Of these, 8 are libraries situated in China and Spain. Because of the unsettled condition in those countries, it seems unlikely that these dues can be collected at the present time. A somewhat similar situation is found in regard to German libraries. Apparently there is some difficulty for Germans in paying amounts even as small as $5.00 to a foreign country. These matters, however, the treasurer hopes to clear up and does not anticipate any loss of dues from this source.

It should be pointed out that, with 587 active members of the Society

paying $1.00 each into the treasury ($4.00 of their dues having been passed on to Dr. SARTON for *Isis*), the maximum income from this source is thus limited to less than $600 a year. With a few individuals not paying, the income is probably, on an average, not more than $550 a year. The expenses of running the office, even without honorarium to the secretary-treasurer, amounts to practically this amount, although possibly $100 a year can be saved. The increase in membership of 30, therefore, is very welcome. Had we not received over $200 in royalties, the Society would not have met its obligations during the past year. It is, perhaps, unfair, however, to draw too many conclusions from the treasurer's report this year. More than half the members had already paid their bills for the year to the previous treasurer by February 15th, 1938 and of this amount, roughly over $300, only $75 was turned over to the present treasurer. It is not, therefore, until a year from now that a true estimate can be made of the financial situation. A financial statement is added to this report.

The secretary-treasurer is greatly indebted to Dr. R. G. SEEGER for his help in transferring the records from Washington to Boston, and also to Professor RICHARD H. SHRYOCK for the arrangement of the program of this meeting. He wishes, too, to acknowledge the many courtesies extended to him by Dr. SARTON in helping him puzzle out the minor details associated with his office.

December 1, 1938.

HENRY R. VIETS,
Secretary-treasurer.

TREASURER'S REPORT

February 15—*December* 1, 1938

INCOME

Received from previous treasurer		$75.43
Dues, 1937	$20.00	
Dues, 1938	1002.24	
Dues, 1939	185.00	1207.24
Gifts		11.00
Royalties		231.20
		$1524.87

EXPENSES

Osiris, Transferred to	$10.00
Isis (226 subscriptions at $4.00)	904.00
Stamps	51.31
Secretary	169.20
Supplies	122.13
American Council of Learned Societies	25.00
Miscellaneous	2.00
Bank Charges and Exchange	18.25
Balance, December 1st, 1938	222.98
	$1524.87

REPORT OF THE COUNCIL MEETING CHICAGO, 1938

The Council and guests met informally at luncheon at the Hotel Stevens, December 29, 1938. President LEAKE presided and among those present were SARTON, SIGERIST, SHRYOCK, CREW, LUCKHARDT, DURAND, DE SANTILLANA, SCHLUETER and VIETS. The report of the secretary-treasurer was read and accepted. Various topics were discussed by the members of the Council, including our relations to the American Historical Association and the American Association for the Advancement of Science, efforts towards publicity, increase in membership and matters in relation to the program. It was voted to express the appreciation of the Council to Dr. SHRYOCK for arranging the program for this year and to thank the Boston Medical Library for the courtesy of extending to the Society the use of quarters for the secretary-treasurer.

The Council met also after dinner at the Palmer House, Chicago, on December 29th, 1938. President LEAKE presided and SARTON, MORRIS, DURAND, SHRYOCK, SPECTOR, SCHLUETER, FLEMING, DE SANTILLANA, SIGERIST and VIETS were present. Professor C. W. MORRIS invited the Society to take an active part in the Fifth International Congress for the Unity of Science to be held at Harvard University, September 5th to 10th, 1939. The Council voted to sponsor this Congress and SARTON, SIGERIST and VIETS were appointed as a committee to arrange for a program for one session of the Congress. It was also voted to take an active part in the International Congress of Mathematicians, meeting at Harvard University, September 4th to 12th, 1940. It was felt that

the Society should be officially represented. In general, the Council expressed their desire to cooperate with any international organization having a congress and requested the secretary to make inquiries in regard to historical sections at such meetings.

The record of the previous Council meeting was read and approved. The office of Recording Secretary was abolished. Dr. SARTON read his report as editor of *Isis*, pointing out that two volumes had been published for 1938. In 1939 he will probably publish not more than 800 pages instead of 1200. His report was accepted. The question of increase of membership of the Society was again discussed. It was voted to accept the resignation of Professor G. S. BRETT and to express our appreciation for his service on the Publications Committee. In regard to future manuscripts submitted to the Society for their approval in relation to application for funds from the American Council of Learned Societies, the Secretary was empowered to appoint a committee for each publication and to incorporate the opinion of the committee into a report for the American Council of Learned Societies.

Dr. SHRYOCK addressed the Council in regard to their relations with the American Historical Association, pointing out that more effort should be made to stimulate an interest in the Society among historians. President LEAKE requested Dr. SHRYOCK to prepare a statement on this subject to be presented at the next Council meeting.

Dr. SIGERIST made an eloquent plea for an Institute for the History of Science, following out the ideas already stated by Dr. SARTON in three published statements. President LEAKE requested a statement on this matter from Dr. SIGERIST to be presented at the next meeting.

At the suggestion of Dr. SIGERIST, Dr. SARTON was unanimously elected Honorary President of the History of Science Society, with his dues permanently remitted. A motion of thanks to Dr. LEAKE, the outgoing President, who has served the Society so faithfully for three years was proposed by Dr. SARTON and voted by the Council.

President LEAKE appointed SPECTOR and DURAND to report on the ballots for officers. The following officers were declared elected : President, HENRY E. SIGERIST ; Vice-Presidents, RICHARD H. SHRYOCK, LOUIS C. KARPINSKI ; Secretary-Treasurer, HENRY R. VIETS ; Council : F. R. MOULTON, H. FISCHER, C. L. G. PRATT, KENNETH FRANKLIN, ERIC WALLER. The President appointed SCHLUETER and FLEMING as auditors of the Treasurer's report. They reported that the accounts had been audited and found correct.

President LEAKE read a brief statement in regard to the aims of the History of Science Society and suggested that such a statement might be expanded and used for publicity. He also expressed a desire to

issue a statement on the freedom of science. The Council was unanimously in accord with these views.

Dr. SIGERIST was installed into the office of President by Dr. LEAKE and expressed his desire to carry forward the aims of the History of Science Society.

Respectfully submitted,
HENRY R. VIETS,
Secretary.

December 29, 1938.

COUNCIL FOR 1938-1939

Elected in 1936 to December 1939.

OTTO GLASSER
SANFORD V. LARKEY
GREGORY D. WALCOTT
JAMES F. COUCH
VICTOR F. LENZEN

Elected in 1937 to December 1940.

RUFUS COLE
RICHARD H. SHRYOCK
ALFRED M. TOZZER
R. C. ARCHIBALD
FRANK DAINS

Elected in 1938 to December 1941.

F. R. MOULTON
H. FISCHER
C. L. G. PRATT
KENNETH FRANKLIN
ERIC WALLER

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Indices to *Isis* have appeared in Vol. I and in subsequent volumes of which the ordinal number is divisible by three. We would advise readers to put some mark (e.g. the word index) on the backs of the volume containing an index.

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